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FOOD PREFERENCE AND GROWTH RATE OF *PORCELLIO LAEVIS* REARED ON DECOMPOSING LEAF LITTER

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(*Received* 15 *December* 1989)

Laboratory findings on the feeding preference, faecal production and growth rate of a common terrestrial isopod, *Porcellio laevis*, reared at 27±0.5°C on decomposing leaf litter of 10 different tree species are presented. Rate of faecal production was more on 'kadam' and *Casuarina* litter but very low in the case of bamboo. A positive relationship between the progress of microbial decomposition and faecal production could be noticed. Weight loss of litter due to microbial action was highest on *Casuarina* and lowest on bamboo. Rate of ingestion as well as faecal production was more on 'kadam' but absorption was more on blackberry litter. More than 10% absorption efficiency could be noted on blackberry, 'kadam', *Cassia*, *Casuarina*, bamboo and *Acacia* leaves. Growth of juveniles occurred at a rapid rate and the average range of live weight after 150 days was 5.45 mg on *Cassia* and 1.2 mg on bamboo litter. Microbial decomposition of litter enhanced their growth and the juveniles could only attain 50% of the normal weight on 'kadam' litter treated daily with 1% streptomycin solution.

(*Key words: Porcellio laevis*, terrestrial isopod, feeding preference, faecal production, growth rate, litter feeding)

INTRODUCTION

Among Isopoda (Crustacea) the sub-order Oniscidea represents an interesting line of evolution to lead a completely terrestrial life. Though they exploit a wide variety of food, a preference is often observed for decayed plant litter as expressed by frequent visits to food source and by higher rates of ingestion (RUSHTON & HASSALL, 1983). Isopods are generalist macrosaprophagic primary decomposers of organic matter effecting mechanical reduction of litter through voracious feeding habits (SUTTON, 1980; KOSCHIELNY, 1982), thereby playing an important role in the recycling of nutrients. According to WERNER & DINDAL (1987), knowledge and understanding of nutritional ecology and other aspects of soil inhabiting macroarthropods in decomposition system may find useful application in agriculture, disturbed land reclamation and human waste disposal. In India, population ecology of terrestrial isopods has not been studied in detail and noteworthy contributions are by MENON et al. (1969) and by NAIR (1984). The present paper incorporates laboratory findings on the relationship among rate of ingestion, faecal production and growth rate of a common terrestrial isopod, *Porcellio laevis* (Latreille) with respect to microbial decomposition in the leaf litter of 10 different tree species.

MATERIAL AND METHODS

Fresh specimens of *P. laevis* were collected from their natural habitats at Santiniketan. They were sorted out into different size groups, put to starvation for 48 hours in polythene cells having moist plaster of paris base and then maintained on decomposing leaf litter in a BOD incubator at 27± 0.5°C. Senescent leaves collected from 10 different tree species namely 'kadam' (*Anthocephalus chinensis*), mango (*Mangifera indica*), acacia (*Acacia auriculiformis*), cashew (*Anacardium occidentale*), guava

(*Psidium guajava*), blackberry (*Sysygium cuminii*), casuarina (*Casuarina equisetifolia*), 'shal' (*Shorea robusta*), cassia (*Cassia siamea*) and bamboo (*Bambusa aurundinacea*) were properly air dried, cut into small pieces and stored in a desiccator over fused calcium chloride at room temperature until needed. For the feeding experiments weighed quantities of the litter were rehydrated with distilled water and offered to known number of laboratory acclimatized adult specimens in triplicate sets. Small quantities of distilled water was regularly added to maintain moderate microbial activity or the litter and the number of isopods were kept constant by replacing dead specimens. The accumulated faecal pellets were sorted out at weekly intervals, cleaned under dissecting binocular microscope, ovendried at 55 to 60°C and weighed. At the end of the experiment remaining fragments of litter were also ovendried at 55 to 60°C and weighed. Control cells were maintained similtaneously to estimate weight loss of litter due to microbial activity. The findings were computed to study weight loss, food preference, rates of ingestion and ejestion and assimilation efficiency using simple consumption and utilisation indices. Experiments on the growth rate of *P. laevis* were conducted by offering 6 well preferred and decomposing litter types to known number of laboratory bred 1 day old juveniles in sets of small rearing cells. Average fresh weight of the juvenile picked up at random was estimated at monthly intervals upto 150 days and small quantities of decomposing litter and distilled water were regularly added to ensure adequate food supply. In another experiment the relationship between microbial decomposition of litter and growth rate of fresh juveniles was studied using 'kadam' litter soaked daily in 1% streptomycin sulphate solution. Trial experiments showed that treatment of 1% streptomycin solution on litter does not affect the food preference and feeding of *Porcellio* sp.

RESULTS AND DISCUSSION

Relevant findings are summarised in Fig. 1 and Tables 1 to 5. The average rate of weekly faecal production of *P. laevis* and an indirect idea of food preference are incorporated in Table 1. The amount of faecal

TABLE 1. Rate of faecal production by *Porcellio laevis* in relation to leaf litter decomposition.

Litter samples	average dry weight per individual in mg				
	1st week	2nd week	3rd week	4th week	Total
'kadam'	3.v9	3.79	4.38	4.81	16.07
mango	0.70	0.93	0.83	1.25	3.71
Acacia	1.05	0.61	0.52	1.08	3.26
cashew	1.68	1.46	2.13	2.25	7.52
guava	1.70	1.81	0.50	0.63	4.64
blackberry	0.65	2.12	2.00	1.87	6.64
Casuarina	2.98	4.55	4.57	3.25	15.35
'shal'	1.08	1.00	0.50	0.42	3.02
Cassia	1.10	1.92	1.44	2.91	7.37
bamboo	0.50	0.33	0.38	0.65	1.86

pellets gradually increased in all the litter except for guava, 'shal' and bamboo; which indicates their feeding preference. Total dry weight of pellets was high on 'kadam' and *Casuarina* but very low on bamboo. DUNGER (1958) showed that *Porcellio scaber, Oniscus asellus, Ligidium hyphorum* and *Armadillidium vulgare* defaecated more when fed overwintered tree leaf litter than when fed fresh litter of the same plant, suggesting that decayed leaves were more palatable. Palatability of litter depends on the quantitative chemical defences of the plant species like soluble tannins and alkaloids. According to HASSALL & RUSHTON (1984) isopods in general prefer dicotyledonous species to grasses. They demonstrated increase in the palatability of *O. asellus* with the extent of microbial conditioning of litter and significant negative correlation between food preference of *P. scaber* and polyphenol content of litter.

Table 1 suggested that decomposing litter may not provide enough food to the animals for a long period. Therefore, litter samples previously subjected to microbial decomposition for a period ranging from 1 to 4 weeks were simultaneously offered along with undecomposed fresh samples to well starved adult specimens in triplicate sets for one week. The average faecal production per individual specimen (Fig. 1) shows progressive trend on 'kadam', *Acacia*, blackberry and *Casuarina*. In guava and cashew more or less uniform level occurred but in *Casuarina*, 'shal' and bamboo litter faecal accumulation notably increased after 3 weeks decomposition. EDWARDS (1974) noted that one of the main factors that influences palatability of isopods is the sort and amount of polyphenols in litter. Leaves rich in polyphenols (e.g. *Fagus*) are not eaten until these chemicals are broken down or leached out; but on the contrary, leaves with low polyphenol content such as *Fraxinus* and *Acer* are readily eaten. Figure 1 also shows some decline in the amount of faecal matter in the 5th week on 'kadam', mango and bamboo litter. HASSALL & RUSHTON (1984) suggested that the activities of microflora on litter help the isopods by accelerating the

TABLE 2. Weight loss of decomposing litter and relative feeding efficiency of *Porcellio laevis*.

Litter samples	average dry weight in percentage					
	Initial dry weight of litter (mg)	Total weight loss after 1 month	Weight loss by microbial action	Apparent rate of ingestion	Weight of faecal matter	Approximate assimilation
'kadam'	169.7	48.7	11.6	37.2	29.4	7.8
mango	184.0	22.6	15.3	7.2	6.6	0.6
Acacia	244.0	27.5	22.0	5.5	4.8	0.7
cashew	134.0	35.1	15.2	19.9	18.9	1.0
guava	108.3	27.2	9.7	17.6	17.1	0.5
blackberry	215.7	26.8	9.7	17.1	10.7	6.4
Casuarina	242.3	65.8	30.7	35.1	29.7	5.4
'shal'	177.5	18.1	11.6	6.6	6.4	0.2
Cassia	104.8	54.8	26.9	28.0	22.7	5.3
bamboo	105.6	14.0	8.6	5.4	4.7	0.7

breakdown of physical defenses, increasing the nutrient status of litter, utilizing the microbes themselves as food and by harnessing the exoenzymes of microbes like cellulases for use in their own guts. In the present study the specimens could not survive well in *Cassia* cells due to excessive fungal growth on the litter (Fig. 1) but such a drawback did not appear in any other continuous feeding experiments. HANLON & ANDERSON (1979) noted that grazing by Diplopoda, Isopoda and Collembola tend to reduce fungal growth but increase bacterial standing crop on litter.

WERNER & DINDAL (1987) pointed out that macrophytophagy and microphytophagy are the major feeding habits of Isopod when compared to coprophagy, necrophagy, or zoophagy. However, coprophagy is a common feature in the nutrition of isopods and the obvious explanation is that enhanced microbial action increases the nutrient status of moist faeces (HASSALL & RUSHTON, 1982).

The percentage weight loss of litter due to microbial action and the relative feeding efficiency of *P. laevis* are depicted in Table 2. During the 28 days experimental period maximum weight loss occurred in the case of *Casuarina, Cassia* and 'kadam' leaves and minimum on bamboo, 'shal' and mango litter. Weight loss by microbial action was highest in *Casuarina* followed by *Cassia* and *Acacia,* whereas negligible loss occurred on bamboo, guava and blackberry. The difference was taken as the apparent rate of ingestion. Table 2 also shows that cumulative faecal production was more on 'kadam' and *Casuarina* litter. The approximate assimilation of food was more or less at a high level on 'kadam', blackberry, *Casuarina* and *Cassia* litter but in all other cases the percentage was quite negligible. An inverse relationship between rate of ingestion and efficiency

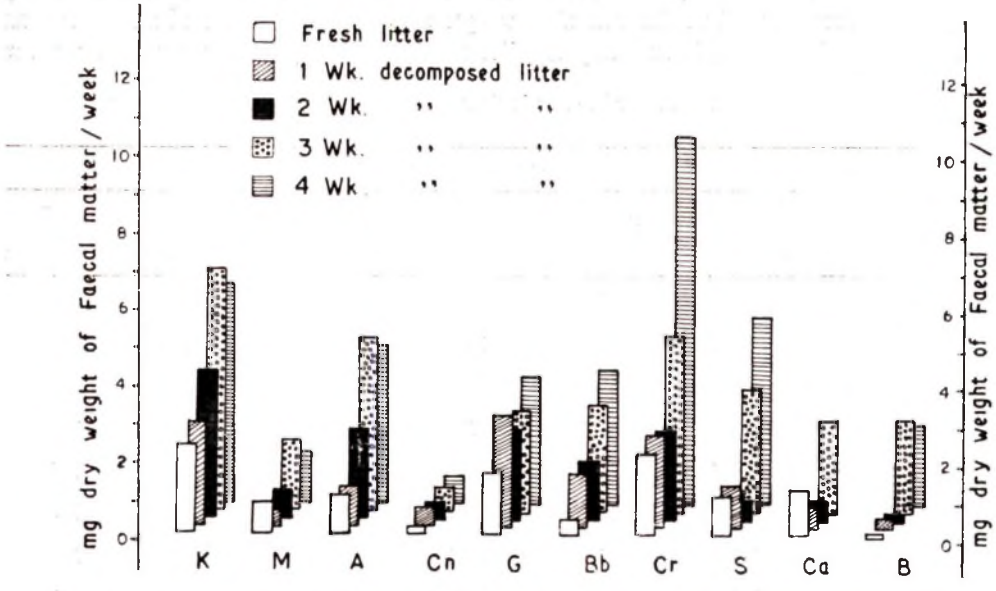

Fig. 1. Average rates of weekly faecal production per individual of *Porcellio laevis* exposed simultaneously to different intervals of leaf litter decomposition.

Abbreviations: K—Kadam; M—Mango; A—Acacia; Cn—Cashewnut; G—Guava; Bb—Blackberry; Cr—Casuarina; S—Shal; C—Cassia; B—Bamboo.

of absorption in macroarthropods like isopods has been reported by several workers. DALLINGER & WIESER (1977) demonstrated this is *P. laevis* fed on birch litter treated with different amounts of copper sulphate, where the amount of organic matter absorbed remained almost constant even though the rate of ingestion varied almost eightfold. WIESER (1984) suggested that under natural conditions generalist feeders like isopods obtain their nutrients and energy by switching from one type of food to another and by varying the rate at which digested food is absorbed across the gut.

A detailed consideration of the findings given in Table 2 was made by converting the percentage values into ingestion and absorption indices and a relative idea of the rates of energy processed by the animals (mg dry weight of energy per gram fresh weight of specimen per day) in different litter is presented in Table 3. Some clear inference on the energy budget of *P. laevis* could be made because the data is free from any ambiguity on the density or biomass of the test specimens. Maximum ingestion occurred on *Casuarina* litter followed by 'kadam' and blackberry, but absorption was highest on blackberry followed by 'kadam' and *Casuarina*. Of all the litters, ingestion was minimum in *Acacia* and bamboo but assimilation was very low in 'shal' and guava, suggesting that *Porcellio* sp. do not prefer these leaves. On the other hand, absorption efficiency in *Cassia* litter was more than that in the case of *Casuarina* (Table 3). 'Kadam', *Acacia*, blackberry, *Casuarina Cassia* and bamboo registered more than 10% absorption efficiency and these were, therefore, used for detailed growth studies. EDWARDS (1974) opined that the range of assimilation in Isopoda varies from 10 to 70% of the food consumed, which can be explained on the basis of abundance of food and the speed at which these materials are passed through the gut. On the other hand, WERNER & DINDAL (1987) suggested that isopod has an ingestion power of 1 to 5% of the available organic matter and an assimilation efficiency upto 50%.

TABLE 3. Comparison of the energy budget in *Porcellio laevis*.

Litter samples	Rates (mg (dw) gram (fw)$^{-1}$ day^{-1}		Absorption efficiency (%)
	Ingestion	Absorption	
'kadam'	131.3	27.5	20.94
mango	35.7	2.9	8.12
Acacia	30.7	3.4	11.07
cashew	71.4	3.6	5.04
guva	50.8	1.4	2.76
blackberry	105.0	39.5	37.62
Casuarina	150.5	23.2	15.42
'shal'	40.6	0.9	2.22
Cassia	80.9	15.3	18.91
bamboo	31.6	3.9	12.34

TABLE 4. Growth rate of *Porcellio laevis* reared on decomposing leaf litter at 27 ± 0.5°C.

Litter samples	average fresh weight in mg					
	Initial	30 days	60 days	90 days	120 days	150 days
'kadam'	0.186	1.00	1.25	1.46	1.68	2.63
Casuarina	0.185	0.40	1.45	2.40	3.25	4.00
blackberry	0.186	0.60	1.09	2.05	2.40	3.11
Cassia	0.187	1.34	2.56	3.15	4.85	5.45
Acacia	0.185	0.50	0.60	0.50	1.10	1.50
bamboo	0.186	0.60	0.70	0.80	0.90	1.20

TABLE 5. Growth rate of *Porcellio laevis* reared on litter with controlled microbial decomposition at 27 ± 0.5°C.

'kadam' litter	average fresh weight in mg					
	fresh juveniles		15 days old		30 days old	
	Number living	Average weight	Number living	Average weight	Number living	Average weight
Litter soaked daily in distilled water	21	0.19	20	0.33	19	1.08
Litter soaked daily in 1% streptomycin	22	0.18	19	0.24	18	0.52

Table 4 shows that the growth of juvenile isopods occurred at a faster rate in *Cassia* litter to record an average weight of 5.45 mg within 150 days. The weight increment was initially slow in *Casuarina* and blackberry but picked up within 90 days to become 2nd and 3rd in position by the end of the experiment. *Acacia* and bamboo litter could not provide adequate nutrition to the growing juveniles. After leaving the brood pouch of the mother young isopods grow fast and the most striking example is of *Hemilepistus reamuri* which grow within 2 months from 10 mg to 160 mg, but during this period the young are fed entirely by their parents (SHACHAK, 1980). There is no such parental care in *Porcellio* sp. and the juveniles lead an independant life, except for the role of some aggregation pheromones as demonstrated by several workers. NAIR (1984) showed that growth of young isopods proceeded at a rate of approximately 0.085 mm in length per day upto 2 month age and thereafter approximately at 0.019 mm, per day. WIESER (1984) also illustrated a fast energy turnover rate of youngest specimens of *P. scaber* and noted a break between a weight-independant phase of metabolism and a weight-dependant phase, occurring at a body weight of 3 to 4 mg. However, the present data is not sufficient to predict any such weight-metabolism relationship on different decomposing leaf litter.

The role of microbial decomposition in enhancing the availability of nutrients is shown in Table 5. The specimens in streptomycin treated cells could attain only about 50% growth when compared to their counterparts in normally decomposing 'kadam' litter. CAREFOOT (1984) used streptomycin sulphate to debilitate gut flora and suggested that administering antibiotics in succession may prove more effective in reducing microbial density. The number of symbiotic bacteria in the hind-gut of *Oniscus asellus* can be very high, 25.5×10^7 gut^{-1}. GRIFFITHS & WOOD (1985) showed that in *O. asellus* the bacteria responsible for digestion might be ingested along with food.

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DUST MITE FAUNA IN HOUSES OF BRONCHIAL ASTHMA PATIENTS – A COMPARATIVE STUDY OF THREE ZONES OF WEST BENGAL (INDIA)

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Analysis of dust of beds and bed rooms of patients suffering from bronchial asthma from three districts of West Bengal (24 Parganas, Barddhaman and Calcutta) reveal the presence of 28 species of mites. Out of these, 13 species are recorded here for the first time from India which include six new species. *Dermatophagoides pteronyssinus* and *D. farinae* are more frequently available than *Hirstia domicola* while the first named species is the most dominant among all mite species. Pyroglyphid mites constituted 62%, 68% and 75%, respectively in the three districts of the total mite fauna and total number of mites/g of dust is maximum both at beds and bed rooms in 24 Parganas. The Median and IQR values of the occurrence of pyroglyphid mites in Calcutta bed dust samples are highest in comparison to those of the other areas while the respective values from bed room dust are lowest in Calcutta.

(*Key words*: dust mites, pyroglyphids, bronchial asthma, West Bengal, India)

INTRODUCTION

Certain species of mites found in the house dust are incriminated as major etiological agents causing atopic asthma and rhinitis in susceptible persons. Among many constituents of house dust causing allergic reactions of respiratory tracts those produced by mites are more potent (VOORHORST *et al.*, 1964; WHARTON, 1976; TRIPATHI & PARIKH, 1983). Studies on house dust mite fauna in India in the past and recent researches reveal the predominance of pyroglyphid mites in house dust samples and those studies give some indications about their role in causing respiratory allergies (KRISHNA-Rao *et al.*, 1973; TRIPATHI & PARIKH, 1983; MAURYA *et al.*, 1983; CHANNABASAVANNA *et al.*, 1984a; TANDON *et al.*, 1986; MODAK *et al.*, 1987). The present study has been undertaken in three districts of West Bengal (24 Parganas, Barddhaman and Calcutta) with a view to exploring and comparing the distribution and abundance of dust mite fauna with special reference to pyroglyphids.

MATERIALS AND METHODS

Bed room floor dust and bed dust samples from "pucca" houses of thirty bronchial asthma patients, 10 each residing in 24 Parganas, Barddhaman and Calcutta were collected in screw capped glass vials by sweeping the floors and dusting the mattresses, pillows and bed sheets over clean sheet of newspapers. It is to be mentioned that none of the houses sampled had any pets. The patients were diagnosed as suffering from bronchial asthma in the Respiratory Unit of the School of Tropical Medicine, Calcutta. All the dust samples were sieved in a mechanical sieve-shaker, using a series of sieves with mesh size of 2.36 mm, 1.00 mm 500 μm and 45 μm. Dust collected on 75 μm sieve was processed following the methods of CHANNABASAVANNA *et al.* (1984b) with slight modifications. One

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gram dust from each sample was mixed with pure kerosence oil and stirred constantly for 10 minutes. The mixture was centrifuged at 100 rpm for two minutes and the supernatant filtered. A mixture of kerosene oil and carbon tetrachloride (sp. gr. 1.3) was added to the sediment in the tube and after centrifuging it was filtered in the same filter paper. The process was repeated with a mixture of kerosene oil and CCl_4 having specific gravity of 1.4, 1.5, respectively. The residue on the filter paper was washed with fine jet of 70% alcohol in a Petri dish. The mites were isolated, mounted and identified.

RESULTS

The mite fauna recovered from house dust samples of the three zones is represented in Table 1. A total of 19, 16 and 21 species of mites under 11, 8 and 12 families were recorded, respectively from 24 Parganas, Barddhaman and Calcutta. The maximum number of mites (1130/g) was recovered from the bed dust and minimum (172/g) from the bed room dust of 24 Parganas.

Pyroglyphids constituted 62%, 68% and 75% of the total house dust mite fauna of 24 Parganas, Barddhaman and Calcutta, respectively. Representative of the family Pyroglyphidae, *Dermatophagoides pteronyssinus* (Trouessart), *D. farinae* hughes and/or *Hirstia domicola* Fain, Oshima and Bronswijk were present in all the dust samples positive for mites and their number/g of dust was higher in beds in comparison to that present in corresponding bed room dust samples.

TABLE 1. List of mite species recovered from house dust samples collected from three districts of West Bengal.

Species	24 Parganas	Barddhaman	Calcutta
A. ASTIGMATA			
1. Pyroglyphidae			
i) *Dermatophagoides pteronyssinus* (Trouessart)	+	+	+
ii) *D. farinae* Hughes	+	+	+
iii) *Hirstia domicola* Fain, Oshima & Brownswijk	+	+	+
2. Acaridae			
iv) *Tyrophagus putrescentiae* (Schrank)	+	+	+
v) *Rhizoglyphus* sp.	+	+	+
vi) *Caloglyphus* sp.	+	+	+
vii) *Acarus* sp.	+	+	—
3. Glycyphagidae			
viii) *Blomia tropicalis* Bronswijk	+	+	+
ix) *Glycyphagus* sp.	+	+	+

Species	24 Parganas	Burdwan	Calcutta
B. PROSTIGMATA			
4. Cheyletidae			
x) *Cheyletus eruditus* Schrank	+	+	+
xi) *C. malaccensis* Oudemans	+	+	+
xii) *Bak* sp. n **	—	+	+
xiii) *Hemicheyletia* sp. n. **	+	—	—
xiv) *Cheyletus trouessarti* Oudemans	—	—	+
5. Pesudocheyletidae			
xv) *Heterocheylus* sp. n.**	—	+	—
6. Tydeidae			
xvi) *Pronematus* sp.	+	+	+
xvii) *Tydeus* sp. *	—	—	+
7. Tarsonemidae			
xviii) *Tarsonemus* sp.	+	+	+
8. Tenuipalpidae			
xix) *Brevipalpus phoenicis* Geijska*	+	—	—
9. Pyemotidae			
xx) *Pyemotes* sp.*	+	—	—
10. Erythraeidae			
xxi) Erythraeus sp.*	+	—	—
11. Scutacaridae			
xxii) *Imparipes* sp. n.**	—	—	+
12. Stigmaeidae			
xxiii) *Zetzellia* sp. n.**	—	—	+
C. MESOSTIGMATA			
13. Ascidae			
xxiv) *Blattisocious* sp.*	—	—	+
xxv) *Lasioseius* sp.*	+	—	—
14. Ameroseiidae			
xxvi) *Kleemania plumosus* Oudemans	+	—	+
15. Phytoseiidae			
xxvii) *Amblyseius largoensis* (Muma)*	—	—	+
16. Laelapidae			
xxviii) *Hypoaspis* sp. n.**	—	+	+
D. CRYPTOSTIGMATA (Undet. sp.)	+	+	+

* New records from Indian house dust samples.
** New species.
\+ indicates presence of the species.
— indicates absence of the species.

TABLE 2. Median and Inter Quartile Range (IQR) of pyroglyphid mites/g of house dust samples in three study districts of East Bengal.

Collection site	24 Parganas		Barddhaman		Calcutta	
	Median	IQR	Median	IQR	Median	IQR
Bed	70	273	100	435.5	160.5	551.5
Bedroom	24.5	121	39	95	24	68

TABLE 3. Statistical analysis of pyroglyphid mite density in bed dust/bedroom dust of three study zones.

Collection site	Zones		Compared	t-value	p-value	Remarks
	24-Parganas	:	Barddhaman	0.46	0.05	Not significant
Bed	24-Parganas	:	Calcutta	0.51	0.05	–do–
	Barddhaman	:	Calcutta	0.09	0.05	–do–
	24-Parganas	:	Barddhaman	0.77	0.05	Significant
Bedroom	24-Parganas	:	Calcutta	0.91	0.05	–do–
	Barddhaman	:	Calcutta	0.15	0.05	Not significant

The Median and Inter Quartile Range (IQR) of the occurrence of the pyroglyphid mites in dust from the three locations are shown in Fig. 1 and Table 2. Highest concentrations of pyroglyphid mites were recorded from Calcutta bed dust samples (Median: 160.5, IQR : 551.5).

The difference in the pyroglyphid mite population in beds and corresponding bed room dust samples of three zones was statistically significant ($p < 0.05$) (Table 3). The difference in the number of pyroglyphid mites/g of bed room dust of 24 Parganas and Barddhaman and 24 Parganas and Calcutta was significant ($p < 0.05$) (Table 3).

D. pteronyssinus was the most predominant species encountered. *Tyrophagous putrescentiae* (Schrank) (Fam. Acaridae) was the second dominant mite species. A total 28 species of mites was isolated of which 13 are recorded here for the first time from the house dust samples from India. Of these, 6 species, *viz. Bak* sp., *Hemicheyletia* sp. (Fam. Cheyletidae), *Heterocheylus* sp. (Fam. Pseudocheyletidae), *Imparipes* sp. (Fam. Scutacaridae), *Zetzellia* sp. (Fam. Stigmaeidae) and *Hypoaspis* sp. (Fam. Laelapdae) are new to science to be described later and the remaining 7 species, *viz. Tydeus* sp. (Fam. Tydeidae), *Brevipalpus phoenicis* Geijsks (Fam. Tenuipalpidae), *Pyemotes* sp. (Fam. Pyemotidae), *Erythraeus* sp. (Fam. Erythraeidae), *Blattio ius* sp. (Fam. Ascidae), *Lasioseius* sp. (Fam. Ascidae) and *Amblyseius largoensis* (Muma) (Fam. Phytoseiidae) have not been so far reported from Indian house dust samples earlier.

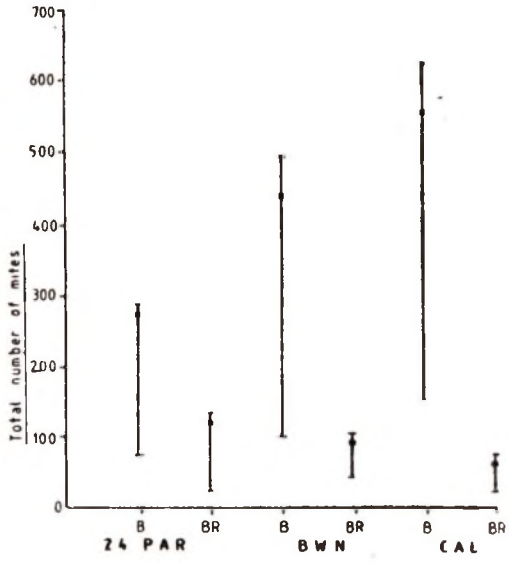

Fig. 1 Median and IQR of pyroglyphid mites/g dust of three study areas.
B = Bed dust. BR = Bed room dust.

DISCUSSION

Results of the present study reveal that the mite fauna in the bed and bed room dust of three study areas is strikingly different from each other, both with regard to population density and in the number of mite species recovered.

Of the 28 species enlisted (Table 1), thirteen (marked *) are being reported for the first time from the Indian house dust samples, of which, six (marked **) are new to science. It is interesting to note that distribution of each of the new species was restricted to one particular area only.

Higher densities of mites were recorded from the bed dust of all the three study areas in comparison to the number present in corresponding bed room dust samples and the difference was significant ($P < 0.05$). Similar observations were also reported earlier (TRIPATHI & PARIKH, 1983; SESAY & DOBSON, 1972; TANDON *et al.*, 1988). HO &NADCHATRAM (1984), however, did not observe significant difference between the mite densities in different niches.

The percentage of pyroglyphid mites contributing to the mite fauna in 24 Parganas, Barddhaman and Calcutta also varied. The difference between pyroglyphid mite density in beds and corresponding bed room dust of three study areas was significant. On comparing the pyroglyphid mite population in bed dust samples of the three study zones, it was noticed that the difference was not significant; the difference in the pyroglyphid mite density in bed room dust of 24 Parganas and Barddhaman and 24 Parganas and Calcutta was, however, observed to be significant (Table 3).

The Median (160.5) and IQR (551.5) of the occurrence of pyroglyphid mites in Calcutta bed dust samples was highest in comparison to the values of the other two study zones. This may probably be attributed to the larger number of persons using the same bed (MULLA *et al.*, 1975) resulting in accumulation of higher quantities of human dander, a most suitable food for the pyroglyphids and mattresses not being dusted regularly. MODAK *et al.* (1987), MULLA & MEDINA (1980) and HO & NADCHATRAM (1984), however, did not find any difference in the average densities of mites in relation to the number of occupants.

On comparing the Median and IQR in respect of bed room dust of the three study zones, the values for Calcutta samples were lowest (Table 2). The practice of cleaning and mopping of bed room floors at least twice a day reduce dust caccumulation and, hence, the reason for lower mite population in Calcutta bed room floors. In suburban West Bengal (Barddhaman and 24 Parganas), the Median and IQR values for floor dust samples was higher, probably due to storage of grains and accumulation of more dust.

D. pteronyssinus was the most common and densely populated species in bed and bed room dust samples on all the three study areas. Earlier workers like KRISHNA-RAO *et al.* (1981), CARSWELL *et al.* (1982), YATANI *et al.* (1984) also made similar observations.

The difference in the mite population in house dust and variation of mite fauna in the three study areas of West Bengal is due to difference in the structure and material of the buildings, socio-economic status of the individuals, type of mattresses used, standard of hygiene maintained and difference in the microclimatic conditions.

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TWO NEW SPECIES OF SUBGENUS *ASPIDAPION* SCHILS. UNDER GENUS *APION* HBST. (APIONINI : APIONIDAE : CURCULIONOIDEA)

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Two new species viz., *mountanus* and *striopunctatus* are being reported under subgenus *Aspidapion* Schils. of genus *Apion* Hbst. of the tribe Apionini.

(*Key words:* new species, *Apion*, curculionid)

Among many other species of subfamily Apioninae, the authors collected two species which are referable to subgenus *Aspidapion* Schils of genus *Apion* Hbst. Both the species are new to science and are being described in the present communication. The important features of the subfamily Apioninae and a key to the Indian tribes of this subfamily have already been reported (Bhateja and Pajni, 1988).

Subgenus *Aspidapion* Schilsky 1901. Schilsky, Kust. Kraatz Kafer Eur., 38:43. 1977. Dieckmann, Beitr. Ent., 27(1): 23, 47. Type-species: *Apion validum* Germ.

Distribution: Palearctic, Madagascar and Oriental regions.

Body clothed with fine whitish hairs; frons as wide as base of rostrum; eyes weakly bulged; base of pronotum not deeply bisinuate; scutellum elongated, 3–4 times as long as broad, with a pair of tubercles at base, usually narrowed and raised at apex; parameres not lobed but acutely narrowed towards apex, with fine setae on apex; aedeagus with dorsal plate well developed; endophallus with fine setae, lacking sclerotized plates.

Remarks

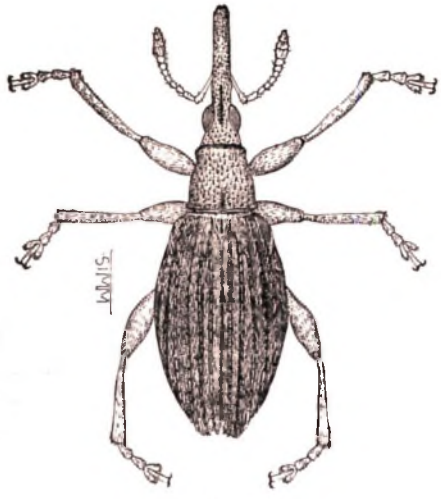
One of the two species studied shows differences from typical *Aspidapion* in having broad and deep striae and the intervals about 1 to 1.5 times as broad as striae but resembles *Aspidapion* in other features. Accordingly, the variable characteristics have been excluded in the characterization of the sub-genus.

KEY TO THE SPECIES OF SUBGENUS *ASPIDAPION* SCHILSKY

1. Elytra twice as long as broad; intervals three times as wide as striae .....*mountanus* sp.nov.
   Elytra 1½ times as long as broad: intervals only slightly wider than striae.....
   .....*striopunctatus* sp. nov.

Apion (Aspidapion) mountanus sp. nov.
(Figs. 1, 2, 3, 4, 5)

Head black, broader than long, punctate, covered with fine and uniformly scattered scale-like white setae, frons flat, wider than base of rostrum, with the setae suberect along margins, with distinct punctures and a longitudinal median furrow ascending on to the rostrum, vertex moderately ascending, with distinct punctures each having an appressed white squamiform seta; temples



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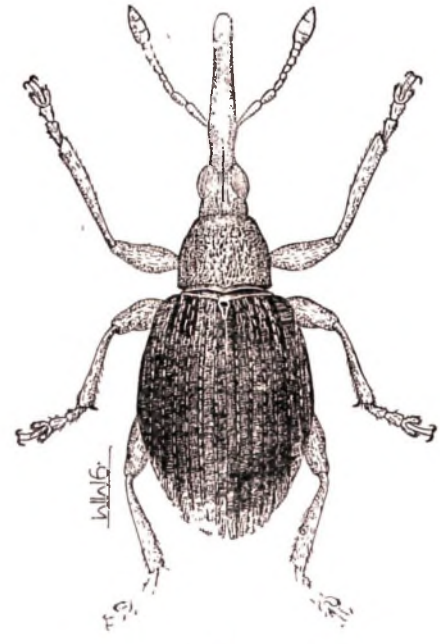

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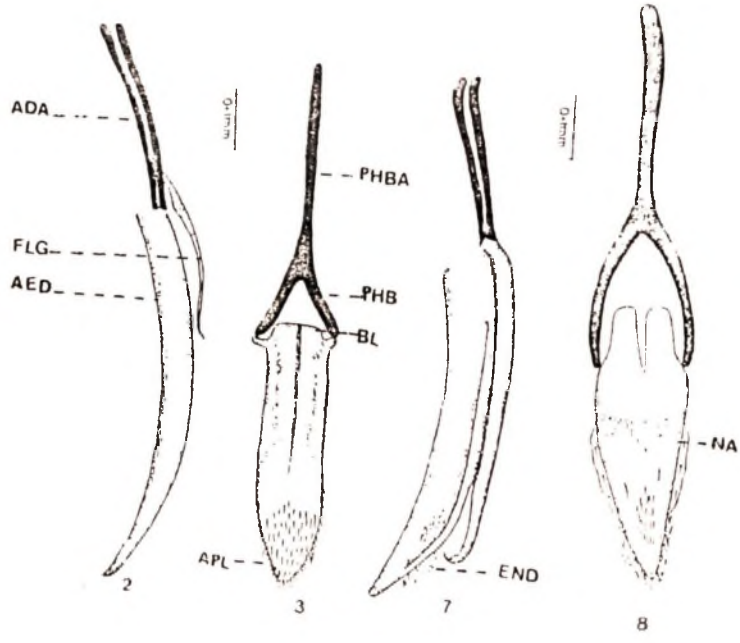
EXPLANATION TO FIGURES (1–10)

1. Adult of *A.* (*A.*) *mountanus* sp. nov., Male genitalia of *A.* (*A.*) *mountanus* sp. nov.; 2. Aedeagus; 3. Phallobase; Female genitalia *A.* (*A.*) *mountanus* sp. nov; 4. Female genitalia; 5. Spermatheca; 6. Adult of *A.* (*A.*) *striopunctatus* sp. nov.; Male genitalia of *A.* (*A.*) *striopunctatus* sp. nov.; 7. Aedeagus; 8. Phallobase; Female genitalia of *A.* (*A.*) *striopunctatus* sp. nov.; 9. Female genitalia; 10. Spermatheca.

Abbreviations used

ADA: Aedeagal apodeme; AED: Aedeagus; APL: Apical lobe; BL: Basal lobe; COR.: Cornu; COX: Coxite; END: Endophallus; FLG: Flagellum; NA: Non- sclerotized area; PHB: Phallobase; PHBA: Phallobasic apodeme; SE: Setae; ST: Stylus; SV: Spiculum ventrale.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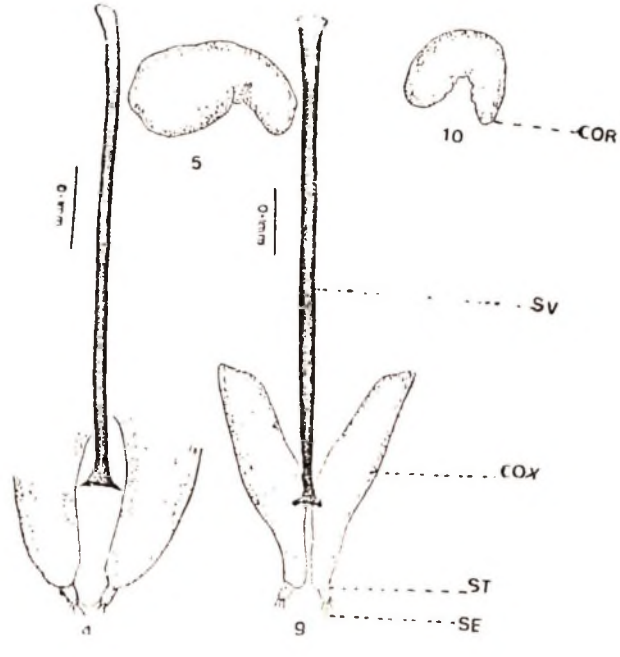
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short, each about 1/5 of the length of an eye, punctate and setose; ventral surface of head with excavated median bare area, with the ocular margins having distinct punctures containing scale-like setae. Eyes black lateral, moderately prominent, separated by a distance nearly equal to the length of an eye. Rostrum stout, slightly longer than the length of prothorax, somewhat curved, at a higher level than frons, slightly dilated at antennal insertions, distinctly punctate and setose, with apex and a median streak bare; ventral surface of rostrum bisulcate, with the sulci punctato-setose and separated by a median impunctate stripe running from apex upto beyond antennal insertions; scrobes with their upper margins extending beyond middle of eyes. Antennae moderately long, inserted near the basal one-fourth of rostrum; scape as long as the basal three funicular segments joined together, clavate at apex, with the apex as thick as the first funicular segment; funicle uniformly clothed with white suberect scale-like setae, segments 1–4 arranged in decreasing order of length, 5–7 transverse; club long, acuminate at apex, densely clothed with setae.

Prothorax distinctly longer than broad, subcylindrical, shining, distinctly punctate, with each puncture having a white appressed seta; pronotum with apical margin truncate and basal margin very feebly bisinuate, with an indistinct transverse carina along apical margin and a small median longitudinal fovea at base; lateral sides of prothorax slightly constricted at apex and at base. Scutellum bare, very much elongated, with apex narrow and blunt, with a basal fovea bounded by a pair of acute tubercles. Thoracic sterna distinctly punctate and setose like dorsal surface, prosternum with a median carina behind procoxae.

Elytra black, shining, elongated, twice as long as broad, with a conspicuous vestiture of white squamiform setate, rounded on the sides, widest before the middle, about one and a half times as broad at shoulders as base of prothorax; shoulders distinct; striae narrow, deep with distinct punctures, somewhat obsolete at apex, with distance between strial punctures as much as breadth of intervals, stria 1 starting from near basal margin of elytra; course of striae in apical portion being 1+2+9, 3+4, 5+6, 7+8; intervals about three times as broad as striae, convex, each with two rows of fine distinct punctures and setae, with setae somewhat densely placed in apical region, interval 9 with a specialized seta near posterior one-third. Legs black, stout, uniformly covered with white hairs; tibiae mucronate; mesocoxae separated; tarsal segment 1 about one and a half times longer than 2 and twice as long as broad; claws appendiculate, each with a broad basal tooth. Abdominal sterna black, distinctly punctate and setose, with the setae suberect on sternites 3 and 4 whereas appressed in others, with the suture between sterna 1 and 2 obliterated in the middle.

Aedeagus nearly cylindrical, in lateral view narrowed and curved downwards towards apex, with phallotreme near apical one-third with dorsal plate narrow and distinct; aedeagal apodemes long and slender, each about one-half the length of aedeagus; endophallus without any distinct armature. Phallobasic apodeme slender, longer than aedeagal apodemes. Parameres elongated, about three-fourths the length of aedeagus, more sclerotized in apical half, truncate at base, not bilobed but narrowed into an acute process at apex, apical one-fourth with fine setae, with a median crest along almost its entire length. Gastral spiculum forked towards base, with median arm less than one-half the length of aedeagus, with basal arms each about one half the length of median arm. Female genitalia with coxites about twice as long as broad. Styli long and tubular, each twice

as long as broad and setose at apex. Spiculum ventrale long and slender, about three times as long as a coxite, slightly curved and dilated at apex. Spermatheca comma-shaped; collum and ramus not differentiated; cornu short and broad, blunt at apex.

Measurements:

	Male	Female
Length of body	2.60 mm	2.70 mm
Breadth of body	1.10 mm	1.10 mm
Length of rostrum	0.55 mm	0.60 mm
Breadth of rostrum	0.20 mm	0.20 mm

Holotype: Male, Batote, Jammu and Kashmir, 26.ix.1977 on grass. **Paratype:** 1, Dalhausie, Himachal Pradesh, 26.v.1976, on grass.

Remarks

This species differs from *cskiii* Gyor. and *striopunctatus* sp. nov. in several characters such as short and thick rostrum, longer club and in the prothorax being not broader than long. Moreover, the intervals of elytra are about three times as broad as striae.

Apion (Aspidapion) striopunctatus sp. nov. (Figs. 6, 7, 8, 9, 10)

Head black, broader than long; frons narrower than base of rostrum, usually bisulcate, with a row of whitish hairs on each side along supraocular margin and another row in each sulcus; vertex and temples indistinct; ventral surface of head shagreened anteriorly and transversely wrinkled posteriorly. Eyes black, rounded, large, moderately prominent, each with a distinct fringe of setae on the lower margin. Rostrum much longer than head and prothorax together in female, hardly as long as head and prothorax in male, curved, feebly dilated at antennal insertions, shagreened, with four rows of small hairs from base upto antennal insertions followed by shining and finely punctate area upto apex; lateral sides of rostrum with a distinct median carina flanked by a punctate furrow on each side, bare in female and with fine setae in male lower surface of rostrum with a broad shining impunctate stripe extending from apex to antennal insertions and then abruptly narrowed into a ridge separating scrobes for most of their length, with a distinct median carina from apex to antennal insertions. Upper margins of scrobes each not reaching ventrally upto middle of eye in the form of a ridge. Antennae long and slender, clothed with greyish-white fine setae, inserted at basal one-fourth in male and at basal one-fifth in female scape piceous, nearly as long as 1–3 funicular segments combined together, clavate apically funicular segment 1 slightly thicker than apex of scape and as long as 2–3 combined together, 3–4 subequal and each longer than broad, 5–6 nearly as long as broad, 7 transverse club oval, acuminate at apex.

Prothorax subcylindrical, slightly broader than long, narrower at apex than at base; pronotum with anterior margin truncate and posterior margin very feebly bisinuate, its surface with shallow to distinct punctures each beset with a fine greyish-white hair, with an indistinct basal median fovea lateral sides of prothorax rounded in the middle, constricted near apex as well as just before base, with a deep pit on each side behind anterior margin. Scutellum nearly double as long as broad, acutely narrowed towards apex, with a pair of tubercles at base. Thoracic sterna black, clothed with whitish hairs; prosternum with a tubercle on the posterior intercoxal process.

Elytra oval, about $1\frac{1}{2}$ times as long as broad, broader at shoulders than base of prothorax, broadest near middle, almost parallel sided from shoulders upto beyond middle and then steeply sloping towards apex; apex, base and lateral margins of elytra clothed with whitish hairs whereas the remaining region with dark brown setae and

appears naked; shoulders distinct, with humeral calli slopping behind; striae deep and catenulate, each with a row of recumbent setae, stria 1 starting from near middle of scutellum; course of striae in apical region being 1+2+9, 3+4, 5+6, 7+8; intervals slightly braoder than striae, coriaceous, each with two rows of recumbent setae, interval 3 with a patch of dense setae at base, interval 9 with a specialised seta in apical one-third. Legs black, clothed with whitish setae; mesocoxae separated, meso- and hind-tibiae in male mucronate; tarsal segment 1 longer than broad, 2 as long as broad; claws appendiculate, each with a broad basal tooth. Abdominal sterna black; first two visible sternites highly convex with the intervening suture obsolete in the middle, coarsely punctate and clothed with distinct white setae; sternite 3 shorter than 4; 5 rounded at apex and clothed with greyish-white very fine setae.

Aedeagus subcylindrical, in lateral view narrowed and curved downwards towards, apex, with apex blunt and not produced with phallotreme subapical; aedeagal apodemes slender, each slightly less than half the length of aedeagus; endophallus beset with numerous setae, without teeth, phallobasic apodeme slender and longer than aedeagal apodemes. Parameres elongated, lacks apical lobes, produced into an acute process at apex, with a fringe of fine setae at apex and along lateral margins, with a pair of narrow transverse non-sclerotized areas somewhat in basal half, with apical two-thirds more sclerotized, produced into a pair of broad and narrowly separated lobes at base. Gastral spicule forked towards base, with median arm thin and about one-third the length of aedeagus, with lateral arms less sclerotised and shorter than median arm. Female genitalia with coxite elongated; each coxite about four times as long as broad, narrowed towards apex. Styli long and tubular; each nearly twice as long as broad and setose at apex. Spiculum ventrale long and rod-like, dilated at apex, twice as long as a coxite. Spermatheca C-shaped; collum and ramus not differentiated, cornu slightly narrowed and blunt at apex.

Measurements in mm:

	Male	Female
Length of body	2.30-2.40	2.25–2.35
Breadth of body	1.00-10 5	1.00–1.05
Length of rostrum	0.83–0.85	1.10–1.15
Breadth of restrum	0.15-0.17	0.15

Holotype: Male; Simla, Himachal Pradesh 1. ix. 1980; on wild bushes. **Paratypes:** 1, same data as holotype; 1, Lumding, Assam; 17.iv. 1979; 1; Baguri, Assam; 24.iv.1979; 1, Jaldapara forest, West Bengal 15.iv.1979; 1, Ghoom, West Bengal; 11.iv. 1979. All from wild bushes.

Remarks

This species is quite close to *csikii* Gyar. but differs from the same in having the front narrower than the base of pronotum, funicular segment 2 longer than 3 and the striae relatively broader and more deeply punctured. The frons in *csikii* Gyar. is as broad as base of pronotum, segments 2 and 3 of funicle are equal and the elytral intervals are two times as broad as striae which are indistinctly punctate. The examples from Simla differ from the remaining in not having bisulcate frons and in having more distinct punctation on pronotum. The genital structures are, however, exactly alike in all the examples.

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KARYOLOGICAL STUDIES IN SEVEN SPECIES OF COLEOPTERA (SCARABAEIDAE) FROM INDIA

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Chromosome number, sex mechanisms and male meiosis in seven scarabaeid beetles have been reported. Five of them viz., *Copris indicus*, *Orthophagus gazella*, *O. hindu*, *Gymnopleurus gemmatus* and *Scarabaeius gangeticus* exhibit $2n=20$, X_{yp} while the remaining two, *Apogonia nigricans* and *A. ferruginea* have $2n=19$, XO. Structural rearrangements, loss of autosomes, loss of Y etc. have been contemplated for the evolution of karyotypes of the studied species concerned.

(*Key words:* Coleoptera, chromosomes, meiosis)

INTRODUCTION

Karyologically Scarabaeidae is one of the extensively studied coleopteran families (See SMITH & VIRKKI, 1978). Though phenotypically varied, most of its members, studied so far (about 80%), possess a common chromosome formula, $9AA+X_{yp}$ comprising chiefly biarmed chromosomes. It has not yet been possible to understand fully the principles underlying the chromosomal evolution of this group. The present study is undertaken with a view to add chromosome data from male meiosis of seven species some of which were unknown cytologically and to suggest the possible mechanisms for karyological changes.

MATERIALS AND METHODS

Chromosomal preparations were made from the testicular material of male specimens of 7 scarabaeid species (Table 1) following the method described in a previous communication (BISOI & PATNAIK, 1988). Measurements were done from the camera lucida diagrams of well spread spermatogonial metaphases.

RESULTS

Copris indicus (Figs. 1-4)

As spermatogonial metaphase plates were not available diploid chromosome number of 20 and a X_{yp} sex mechanism have been inferred from metaphase-I plates (Fig. 3). Metaphase-II plates indicate that the autosomes consist of 1 pair of large metacentrics, one pair of large acrocentrics, 2 pairs of medium sized sub-metacentrics and 5 pairs of small acrocentrics (Fig. 4). The sex pair (X and y) belong to the last category.

Zygotene and pachytene stages are stereotype and diplotene bivalents appear as rods and open rings (Fig. 1). Diakinesis and metaphase-I contain 10 highly condensed elements including 3 rings, 3 crosses,, 3 rods, and the smallest heteromorphic sex bivalent X_{yp} (Figs. 2, 3). Metaphase II plates (Fig. 4) contain 9 autosomes and the X or the y.

Orthophagus gazella (Figs. 5-8)

There are 20 biarmed chromosomes in the spermatogonial metaphase which include

TABLE 1. List of studied coleopteran species with their time and place of collection, diploid number and chromosome formula at first metaphase.

Name of species.	Date	Locality	Chromosomes	
			2n	First metaphase
Family - Scarabaeidae				
Sub-family - Scarabaeinae				
Copris indicus Gillet	August 85.	Chatrapur, Orissa India.	20	9 AA + Xyp
Orthophagus gazella Fabricius	–do–	–do–	20	9 AA + Xyp
O. hindu Arrow	July 86	–do–	20	9 AA + Xyp
Gymnopleurus gemmatus Harold	August 85	–do–	20	9 AA + Xyp
Scarabaeus gangeticus Laporte	Dec. 86	–do–	20	9 AA + Xyp
Sub-family : Melolonthinae				
Apogonia nigricans Hope	Aug 85	–do–	19	9 AA + XO
A. ferruginea Fabricius	–do–	–do–	19	9 AA + XO

6 pairs of metacentrics and 4 pairs of submetacentrics (Fig. 5). The X chromosome is one of the smaller metracentrics wile the y is the smallest metacentric in the complement. The size of the chromosomes varies from 6.73 μm to 2.71 μm (Table 2).

A deeply stained block of sex chromatin is present in interphase and leptotene nuclei. The bivalents of diplotene appear wooly (Fig. 6). Diakinetic bivalents are in the shape of rods, open rings and crosses. There are 9 distinct deeply stained dumbbell shaped autosomal bivalents with terminalised chiasma and the X_{yp} at metaphase-I (Fig. 7). Number of chiasma is always one per bivalent located in terminal and interstitial regions. Anaphase-I separation results in two kinds of metaphase-II complements (having 10 dyads each), one with X and the other with y (Fig. 8).

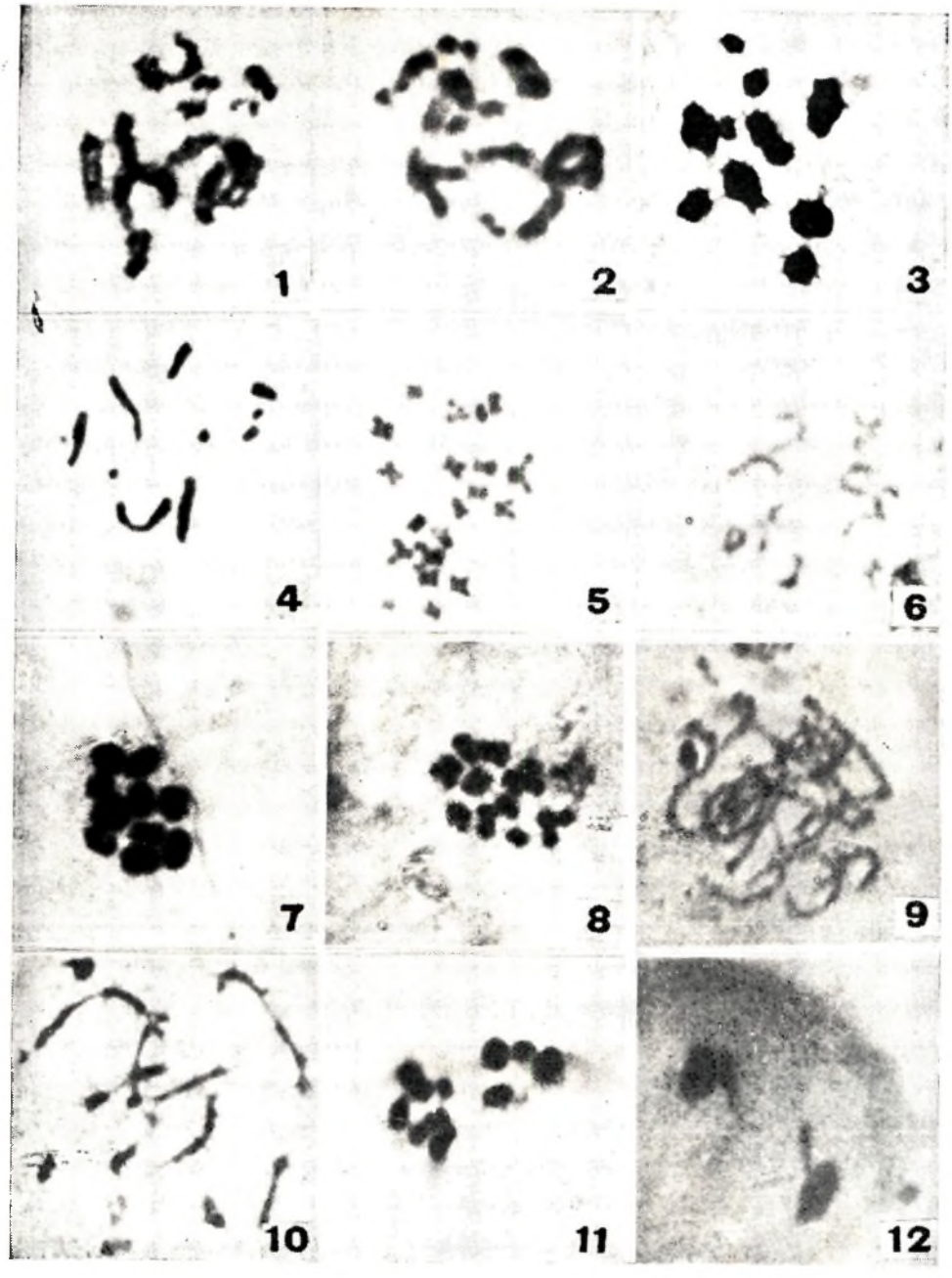
Orthophagus hindu (Figs. 9–13)

This species resembles *O. gazella* not only in number and morphology of the chromosomes but also in almost every detail of the male meiosis. The chromosomes range from 7.34 μm to 2.17 μm in absolute size (Table 2). At anaphase–II, the sex chromosome shows a tendency of lagging behind the autosomes (Fig. 12).

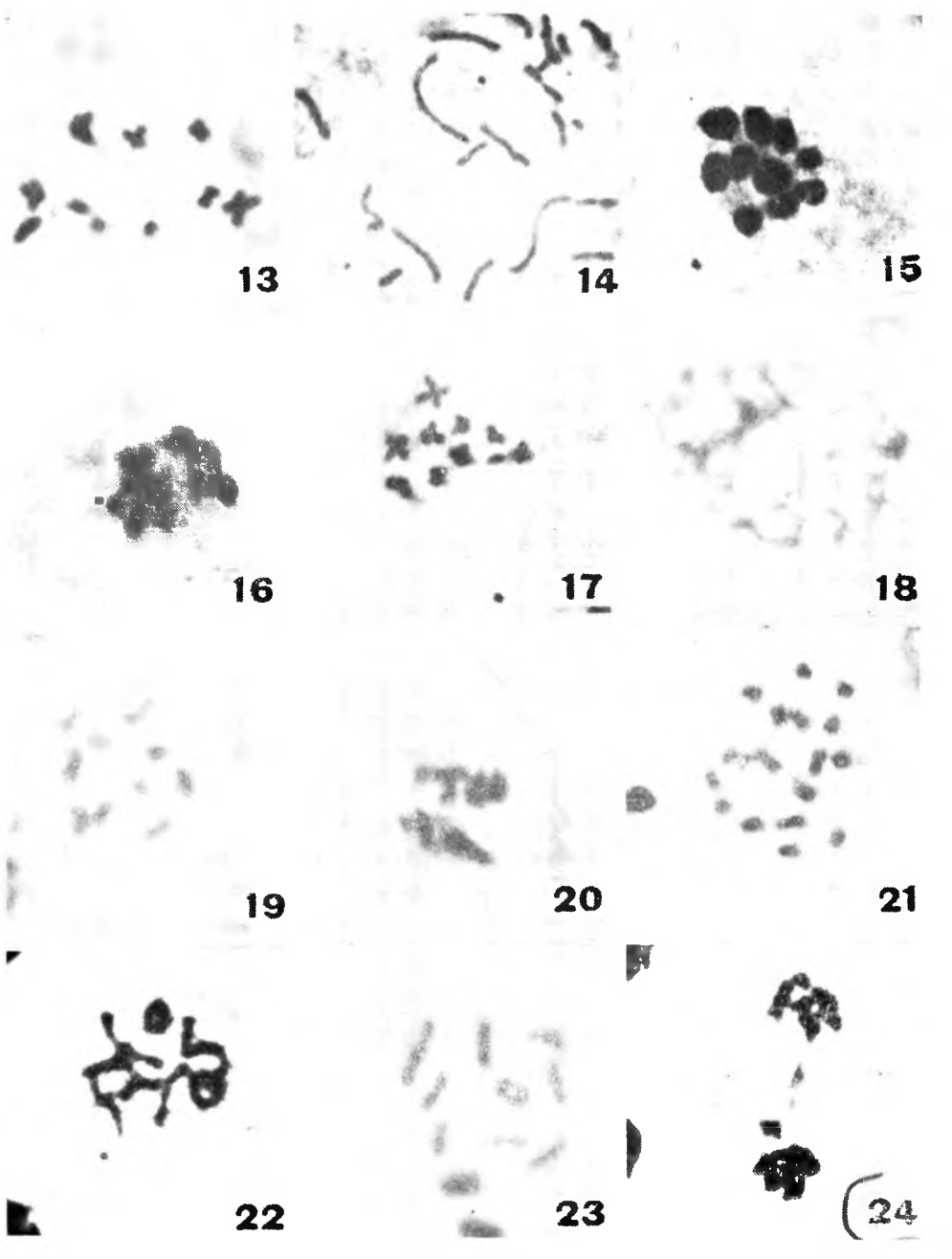
Gymnopleurus gemmatus (Figs. 14–17)

Though the diploid number is 20, the chromosomes do not exhibit their morphology clearly at spermatogonial metaphase (Fig. 14). The sex chromosomes X and y form a parachute. The chromosomes fall within a size range of 9.83 μm to 1.68 μm (Table 2).

Heterochromatic blocks are observed in the early prophase stages including a sex chromatin mass. At diakinesis and metaphase I, the bivalents appeared as darkly stained round opaque bodies which suggested that they might have two chiasmata in some or all of them (Fig. 15). Out of 10 bivalents, one is the X_{yp}. Metaphase-II has 10 biarmed dyads one of which is either X or



Figs. 1–4: Meiosis in *Copris indicus*: 1) diplotene; 2) diakinesis; 3) Metaphase I; 4) Metaphase II. Figs. 5–8: Meiosis in *Orthophagus gazella*: 5) spermatogonial metaphase; 6) diplotene; 7) metaphase I; 8) metaphase II. Figs. 9–13: Meiosis in *Orthophagus hindu*: 9) leptotene; 10) pachytene; 11) 11 metaphase I; 12) late anaphase I. 13) metaphase II.



Figs. 14–17 : Meiosis in *Gymnopleurus gemmatus* : 14) spermatogonial metaphase; 15) metaphase I; 16) anaphse I; 17) metaphase II. Figs. 18–20: Meiosis in *Scarabaeus gangeticus*: 18) leptotene; 19) metaphase I; 20) anaphase I. Figs. 21–25 : Meiosis in *Apogonia nigricans* : 21) spermatogonial metaphase; 22) diplotene; 23) metaphase I; 24) anaphase I; 25) metaphase II.

TABLE 2. The mean absolute (AL) and relative (RL) length of chromosomes in 6 species of beetles under study.

Chrom.	*O. gazella*		*O. hindu*		*G. gemmetus*		*S. gangeticus*		*A. nigricans*		*A. ferruginea*	
	AL	RL	AL	RL	AL	RL	AL	RL	AL	RL	AL	RL
1.	6.73 ±0.08	13.51 ±0.23	7.34 ±0.11	14.39 ±0.27	9.83 ±2.97	17.02 ±2.14	10.30 ±0.27	12.37 ±0.81	6.70 ±0.05	14.34 ±0.28	4.96 ±0.05	13.69 ±0.13
2.	5.45 ±0.18	11.76 ±0.44	6.95 ±0.00	13.62 ±0.16	7.98 ±1.84	13.98 ±1.15	9.73 ±0.58	11.67 ±0.27	5.94 ±0.05	12.72 ±0.23	4.63 ±0.06	12.76 ±0.16
3.	4.72 ±0.11	10.90 ±0.30	6.24 ±0.21	12.24 ±0.28	7.27 ±1.79	12.71 ±1.07	8.82 ±0.80	10.55 ±0.08	5.22 ±0.02	11.17 ±0.15	4.30 ±0.06	11.85 ±0.14
4.	4.45 ±0.08	9.59 ±0.16	5.54 ±0.22	10.88 ±0.34	6.10 ±1.27	10.72 ±0.45	8.65 ±0.95	10.33 ±0.50	5.16 ±0.05	11.02 ±0.07	4.14 ±0.19	11.41 ±0.49
5.	4.34 ±0.00	9.39 ±0.05	4.67 ±0.12	9.15 ±0.26	5.21 ±1.23	9.12 ±0.47	8.25 ±1.00	9.86 ±0.58	4.96 ±0.15	10.63 ±0.23	3.80 ±0.10	10.47 ±0.23
6.	4.10 ±0.10	8.83 ±0.21	4.23 ±0.21	8.29 ±0.35	4.78 ±0.98	8.40 ±0.22	7.60 ±0.86	9.08 ±0.45	4.80 ±0.10	10.29 ±0.10	3.62 ±0.06	9.97 ±0.21
7.	3.82 ±0.18	8.24 ±0.27	4.01 ±0.21	7.87 ±0.33	4.34 ±0.73	7.69 ±0.70	7.12 ±0.66	8.52 ±0.25	4.61 ±0.14	9.88 ±0.19	3.47 ±0.00	9.56 ±0.04
8.	3.55 ±0.24	7.66 ±0.48	3.47 ±0.00	6.80 ±0.08	3.85 ±0.05	6.88 ±0.70	6.73 ±0.48	8.07 ±0.25	4.45 ±0.12	9.52 ±0.22	3.47 ±0.00	9.56 ±0.04
9.	3.28 ±0.18	7.07 ±0.35	3.41 ±0.10	6.70 ±0.27	3.36 ±0.54	6.60 ±1.45	6.35 ±0.40	7.62 ±0.36	4.28 ±0.10	9.17 ±0.12	3.29 ±0.05	9.07 ±0.18
X	3.20 ±0.20	6.90 ±0.41	2.93 ±0.00	5.75 ±0.08	4.44 ±0.37	4.33 ±0.52	5.74 ±0.63	6.87 ±0.44	0.54 ±0.12	1.15 ±0.26	0.57 ±0.12	1.58 ±0.35
Y	2.71 ±0.22	5.84 ±0.50	2.17 ±0.00	4.25 ±0.08	1.68 ±0.20	3.00 ±0.42	4.13 ±0.00	4.96 ±0.39	— —	— —	— —	— —

Y (Fig. 17).The division is reductional at anaphase-I (Fig. 16) and equational at anaphase-II.

Scarabaeus gangeticus (Figs. 18–20)

From the spermatogonial metaphases, the diploid number of 20 chromosomes has been determined. The sex mechanism is Xyp. The size of the X is indistinguishable from smaller autosomes and the Y seems to be the smallest element. The sizes of chromosomes vary from 10.30μm to 4.13μm (Table 6).

Early prophase stages exhibit many positively heteropycnotic blocks for which the sex chromiatin mass is difficult to distinguish amongst them (Fig. 18). At diakinesis and metaphase I (Fig. 19), all 10 bivalents except X_{yp} appear rod-shaped. At anaphase-I, the separating dyads appear V-shaped with fine thread like connections between them (Fig. 20). The sex bivalent X_{yp} seems to divide late. Two large irregular and darkly stained blocks of chromatin are marked at two poles of telophase-I. No good metaphase-II plate should be obtained in this species.

Apogonia nigricans (Figs. 21–25)

The spermatogonial metaphase complement comprises 19 biarmed chromosomes (Fig. 21). The sex mechanism is XO in male. The X chromosome is a small submetacentric whose size overlapped with that of a small autosome. The size of chromosomes ranges between 6.70 μm and 0.54 μm (Table 2).

Any large block of heterochromatin representing sex chromatin is absent in early prophase stages. The bivalents of diplotene (Fig. 22), diakinesis and metaphase-I (Fig. 23) are in the shape of rods, rings and crosses. Thus number of chiasmata is one or two in different bivalents found in terminal or interstitial region. The sex chromosome is found to lag behind the autosomes while moving towards one of the poles of anaphase-I (Fig. 24). At metaphase-II, the number of dyads is 10 (with X) and 9 (without X) (Fig. 25).

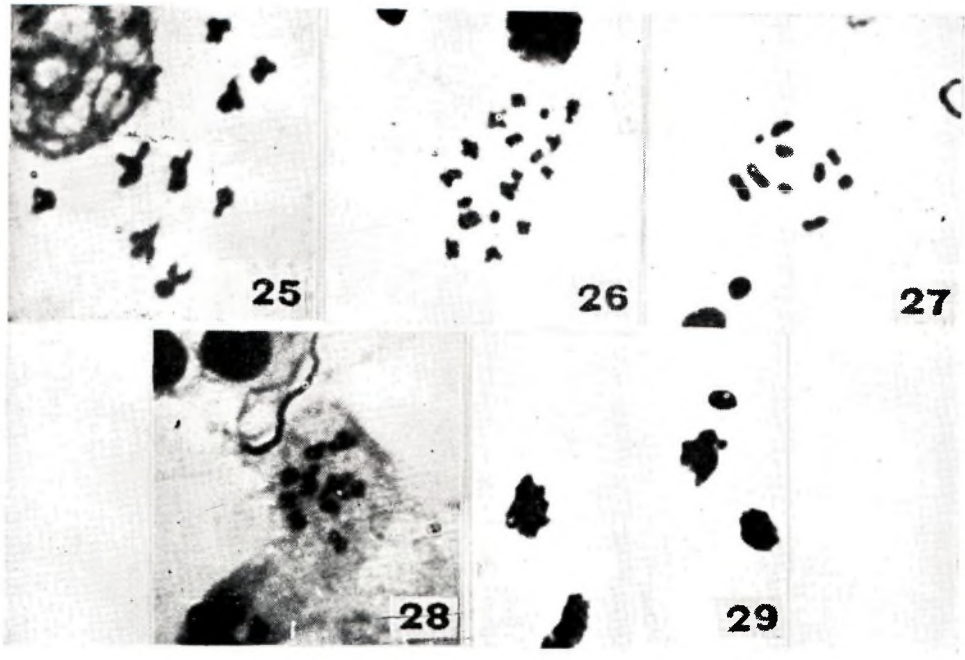
Apogonia ferruginea (Figs. 26–29)

The diploid number of this species is 19 (Fig. 26). Morphology of chromosomes, sex mechanism and the entire meiotic process are the same as described for *A. nigricans*. The size of chromosomes ranges between 4.96 μm and 0.57 μm (Table 2).

DISSCUSSION

About 235 species of this family are karyologically known (DASGUPTA, 1977; SMITH & VIRKKI, 1978). The diploid number ranges between 12 and 22 with a clear mode at 20 ($9AA+X_{yp}$). The sex-mechanisms encountered in this family are X_{yp}, X_{yr}, X_y, XY, neo XY and XO of which X_{yp} is most common as found in our study.

The sub-family Scarabaeinae is also chromosomally very heterogeneous (2n=12–21) but the model number is 20, $18X_{yp}$. The chromosome number in 7 species of the genus *Copris* ranges between 2n=14 and 2n=21 with XO or Xyp sex mechanism in male (SMITH & VIRKKI, 1978). Reduction of chromosome number in this genus from the basic polyphagan condition might have occurred through autosome-autosome fusion (YADAV & PILLAI, 1977). Some 27 species have been cytologically examined in the genus *Orthophagus* prior to our study. All these and two newly studied species (*O. gazella* and *O. hindu* of the present study) have the basic polyphagan karyotype of 2n=20, Xyp. The two species of our study show some closeness in the length of their comparable chromosomes except for chromosomes II, III and IV (Table 2). Chromosomes II, III and IV of *O. hindu*



Figs. 26–29 : Meiosis in *Apogonia ferruginea*: 26) spermatogonial metaphase; 27) metaphase I; 28) metapahase II; telophase I.

have higher absolute as well as relative lengths than those of *O. gazella*.

Previously cytology of two species from the genus *Gymnopleurus* was studied. *G. gemmatus* is added from our study. While *G. sinuatus* (MANNA & LAHIRI, 1972) is reported to have 2n = 18 (8 + X + Y), other species *G. gemmatus* and *G. koenigi* (DASGUPTA, 1963) have a visually identical karyotype of 2n = 20, Xyp.

In the genus *Scarabaeus*, cytological study is limited to 3 species only (SMITH & VIRKKI, 1978). All of them and a new one (*S. gangeticus*) of this study possess the basic polyphagan karyotype of 9AA+Xyp.

Sub-family Melolonthinae is chromosomally more conservative as most of the species possess 2n = 20, Xyp. So far, 7 species from the genus *Apogonia* have been studied cytologically (LAHIRI & MANNA, 1969; KACKER, 1970; MANNA & LAHIRI, 1972; YADAV & PILLAI, 1974 a, b; DASGUPTA, 1977). Chromosome numbers recorded in these species vary from 19 to 21. The sex mechanism in male are reported to be XO. Xyp and Xy. *A. nigricans* and *A. ferruginea* have been reinvestigated by us. While KACKER (1970) recorded 2n=20 (MI=9 + Xyp) for *A. nigricans* we as well as MANNA & LAHIRI (1972) observed 2n = 19 (MI = 9+X). These two species, though exhibit closeness in the relative length of their chromosomes (Table 2), differ from each other significantly in their absolute sizes. Loss of Y coupled with proportionate gain/loss in extra chromatin in the autosomes might have been instrumental in the chromosomal evolution in this genus.

The Xyp mechanism is recorded in 5 species of this study. The X is comparatively large and the Y is always a minute

element. Most probably it is the primitive sex chromosome system of Coleoptera (SMITH, 1950; SMITH & VIRKKI, 1978). However, any chiasma between X and y forming a parachute has not been observed as reported by others (SMITH, 1951, 1973; SANDERSON, 1967; MANNA & SMITH, 1959; KACKER, 1970). Thus in Xyp system, possibility of a chiasma is totally excluded (JOHN & LEWIS, 1960; VIRKKI, 1967). Nucleolar association of X and y is well documented in the reports of JOHN & LEWIS (1960); JOHN & SHAW (1967) VIRKKI (1967) and SMITH & VIRKKI (1978).

We are not very much certain about the presence of a nucleolus in all Xyp systems. Neocleolar association of X and y in such systems has also been questioned by WHITE (1973), POSTIGLIONI & BRUM-ZORRILLA (1975, 1981 a, b), POSTIGILIONI *et al.* (1980) and VIRKKI & MAZZELLA (1984). Thus it may be assumed that the Xyp system may be nucleolar in some and chiasmate in others.

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INTRA-SPECIFIC KARYOTYPIC VARIATIONS IN TWO SPECIES OF POLYPHAGOUS APHIDS (HOMOPTERA : APHIDIDAE)

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Intra-specific karyotypic variations which are statistically significant have been noted among some host plant smaples of two species of polyphagous aphids, namely, *Aphis gossypii* and *Toxoptera aurantii*, collected from 14 and 7 different host plants, respectively, from different parts of India. The significance of the intra-specific karyotypic variations has been discussed in the light of the holokinetic nature of chromosomes in aphids, the parthenogenetic mode of breeding and their possible host-plant preference. Further, the inherent difficulty in drawing up a reliable "standard" karyotype for a given polyphagous species of aphid has been pointed out.

(*Key words:* karyotype, polyphagous aphids, Aphididae, *Aphis*, *Toxoptera*, pest)

INTRODUCTION

The aphids are tiny pest insects, many of whom have altogether lost their sexual mode of reproduction (anholocyclic) secondarily, while some others retain this mode for a brief period during the year (holocyclic), but reproduce parthenogenetically during the greater period. *Aphis gossypii* and *Toxoptera aurantii* are two polyphagous species of aphids belonging to the latter mentioned category.

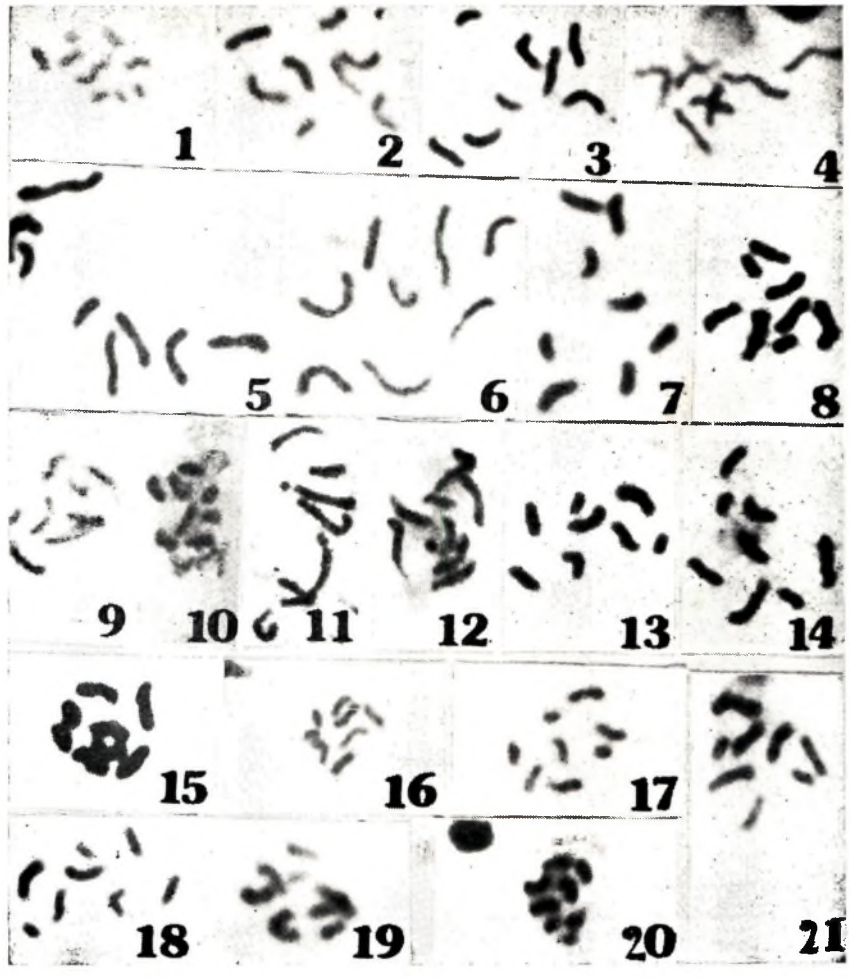
GUT (1976) observed variations in idiograms of certain aphid species published by different workers from different countries. Later, BLACKMAN (1980a, b) also noted that there was difference in the chromosome morphology of some aphids within the species. PAL & KHUDA-BUKHSH (1985a, b) also encountered some karyotypic variations in some natural populations of aphids. But there seems to be no serious and systematic study on the extent of variations within a species infesting different host plants, for which the present study was undertaken.

MATERIALS AND METHODS

In the study, the karyotypes of two species of polyphagous aphids, namely *Aphis gossypii* Glover and *Toxoptera aurantii* B. d. F., collected from 14 and 7 different host plants from different regions of India, respectively, have been critically analyzed. The names and localities of host plant species, and some other relevant data such as temperature and humidity of the place of collection are furnished in Table 1. Giemsa-stained somatic chromosome preparations of embryos of apterous females of *Aphis gossypii* and *Toxoptera aurantii* have been made according to the modified squash-airdrying method described earlier (KHUDA-BUKHSH & PAL, 1985). Representative metaphase complements from each host plant biotype of *A. gossypii* and *T. aurantii* are shown in Figs. 1-14 and 15–21, respectively. Comparative idiograms of *A. gossypii* and *T. aurantii* based on relative percentage lengths of individual pairs of chromosomes in five metaphase complements (Table 2) are presented in Figs. 22 and 23, respectively.

TABLE 1. List of host plants and some other data of collection.

Name of aphid species	Sl. no.	Name of host plants and families	Collection data				
			Locality	Altitude (above sea level)	Temp. °C	Humid. %	Date
Aphis gossypii Glover							
	1.	*Lagenaria vulgaris* (Cucurbitaceae)	Kalyani (W. B.)	75 ft.	20	50	23–1–85
	2.	*Cosmos* sp. (Compositae)	Kalyani (W. B.)	75 ft.	19	52	28–1–85
	3.	*Tagetes* sp. (Compositae)	Kalyani (W. B.)	75 ft.	18	52	28–1–85
	4.	*Citrus* sp. (Rutaceae)	Kalyani (W. B.)	75 ft.	20	60	18–1–87
	5.	*Cassia sofera* (Papillionaceae)	Kalyani (W. B.)	75 ft.	24	57	14–1–86
	6.	*Dahlia* sp. (Compositae)	Kalyani (W. B.)	75 ft.	28	62	4–1–86
	7.	*Callicarpa* sp. (Verbenaceae)	Shillong (Meghalaya)	5000 ft.	18	63	7–11–86
	8.	*Clerodendron viscosa* (Verbenaceae)	Kalyani (W. B.)	75 ft.	23	56	5–2–87
	9.	*Acacia* sp. (Mimoseae)	Kalyani (W. B.)	75 ft.	20	56	26–1–86
	10.	*Artemisia vulgaris* (Compositae)	Shillong (Meghalaya)	5000 ft.	20	67	2–5–87
	11.	*Ageratum conyzoides* (Compositae)	Kalimpong (W. B.)	4000 ft.	22	59	27–5–86
	12.	*Dichanthium annulatum* (Gramineae)	Jammu (J&K)	2000 ft.	25	54	17–10–87
	13.	*Trema aureantalia* (Ulmaceae)	Jammu (J&K)	2000 ft.	25	54	17–10–87
	14.	*Amaranthus bidentatus* (Amaranthaceae)	Jammu (J&K)	2000 ft.	25	54	17–10–87
Taxoptera aurantii B.d.F.							
	1.	*Duranta repens* (Verbenaceae)	Jowai (Meghalaya)	5000 ft.	22	56	13–11–86
	2.	*Artocarpus heterophyla* (Moraceae)	Kalyani (W. B.)	75 ft.	20	70	2–2–87
	3.	*Camellia* sp. (Theaceae)	Kalimpong (W. B.)	4000 ft.	25	59	8–5–86
	4.	Unidentified (Lauraceae)	Shillong (Meghalaya)	5000 ft.	24	52	26–4–87
	5.	*Quercus alba* (Fagaceae)	Shillong (Meghalaya)	5000 ft.	25	55	8–11–86
	6.	*Quercus* sp. (Fagaceae)	Kalimpong (W. B.)	4000 ft.	18	60	15–11–85
	7.	*Dendrobium chrysotoxum*	Kalimpong	5000 ft.	22	50	25–4–85



Figs. 1–21 Photomicrographs of metaphase complements of *Aphis gossypii* (Figs. 1–14) and *Toxoptera aurantii* (Figs. 15–21) collected from 14 and 7 different host plants, respectively. The figure numbers correspond with the serial numbers of the host plants listed in Table 1.

RESULTS AND DISCUSSION

All the different host plant samples of *A. gossypii* (Figs. 1–14) and *T. aurantii* (Figs. 15–21) had $2n = 8$ chromosomes comprising one pair of 'long', two pairs of 'medium' and one pair of 'short' chromosomes lacking any primary constrictions. Although the diploid number was the same in each, there was some variations in their measurement values of individual pair of chromosomes (see Table 2). The statistical correlation ('t' test) did not show the difference to be significant between certain host plant samples, but for some others, the difference was quite significant (see Table 3). But as the same host plant population could not be karyotypically studied from geographically different areas or different altitudes, the impact of ecological

TABLE 2. Mean length (ml) and relative percentage length (RL) of chromosomes in different host plant biotypes of *A. gossypii* and *T. aurantii* expressed as haploid sets.

Name of aphid species		Host plant		Chromosome number							
				1		2		3		4	
				ml(μm)	RL	ml(μm)	RL	ml(μm)	RL	ml(μm)	RL
A. gossypii	1.	*Lagenaria vulgaris*	SE±	5.16 0.52	35.41	3.64 0.61	24.98	3.27 0.36	22.44	2.50 0.35	17.15
	2.	*Cosmos* sp.	SE±	6.08 0.63	29.27	5.86 0.58	28.21	5.08 0.66	24.45	3.75 0.56	18.05
	3.	*Tagetes* sp.	SE±	5.71 0.72	29.60	5.18 0.87	26.85	4.72 0.73	24.46	3.68 0.46	19.07
	4.	Citrus sp.	SE±	7.83 0.98	34.40	6.49 0.98	28.51	4.45 0.83	19.55	3.99 0.72	17.53
	5.	*Cassia sofera*	SE±	7.16 0.68	30.66	6.31 0.39	27.02	5.74 0.25	24.58	4.14 0.32	17.73
	6.	*Dahlia* sp.	SE±	6.88 0.82	30.22	6.11 0.77	26.84	5.52 0.78	24.25	4.25 0.55	18.67
	7.	*Callicaroa* sp.	SE±	6.56 0.71	31.44	5.64 0.74	27.03	4.83 0.39	23.15	3.83 0.42	18.36
	8.	*Clerodendron viscosa*	SE±	5.75 0.21	31.42	4.62 0.28	25.24	4.45 0.29	24.31	3.48 0.18	19.01
	9.	*Acacia* sp.	SE±	5.73 0.44	30.80	5.10 0.40	27.41	4.35 0.50	23.38	3.42 0.23	18.38
	10.	*Artemisia vulgaris*	SE±	4.56 0.49	30.89	4.16 0.43	28.18	3.60 0.52	24.39	2.44 0.43	16.53
	11.	*Ageratum conyzoides*	SE±	10.87 0.76	33.68	9.00 0.76	27.88	7.68 0.75	23.79	4.72 0.14	14.62
	12.	*Dicanthium annulatum*	SE±	5.68 0.02	38.30	3.78 0.17	26.15	2.89 0.25	20.00	2.10 0.40	14.62
	13.	*Trema aureantalia*	SE±	6.38 0.19	29.68	6.11 0.08	28.43	5.00 0.06	23.26	4.00 0.10	18.61
	14.	*Amaranthus bidentatus*	SE±	4.99 0.17	32.99	4.28 0.18	28.76	3.57 0.23	23.99	2.12 0.20	14.24
T. aurantii	1.	*Duranta repens*	SE±	6.39 1.17	33.99	5.42 0.76	28.82	4.04 0.50	21.48	2.95 0.13	15.69
	2.	*Artocarpus heterophyla*	SE±	5.11 1.15	34.18	4.13 0.80	27.62	3.57 0.67	23.87	2.14 0.17	14.31
	3.	*Camellia* sp.	SE±	5.55 0.32	33.15	4.43 0.10	26.46	3.91 0.27	23.35	2.85 0.25	17.02
	4.	Unidentified	SE±	4.53 0.07	32.66	3.67 0.02	26.45	3.09 0.05	22.27	2.58 0.23	18.60
	5.	*Quercus alba*	SE±	4.81 0.89	32.30	4.06 0.54	27.26	3.28 0.44	22.02	2.74 0.26	18.40
	6.	*Quercus* sp.	SE±	5.35 0.12	30.87	4.70 0.23	27.12	4.15 0.42	23.94	3.13 0.52	18.06
	7.	*Dendrobium chrysotoxum*	SE±	4.20 0.37	35.00	3.30 0.42	27.50	2.60 0.24	21.66	1.90 0.29	15.83

TABLE 3. Statistical correlation ('t' test) of karyotypes of *A. gossypii* collected from 14 species of hostplants.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	*	—	**	**	**	**	—	—	—	**	—	*	—	1
		—	—	—	—	—	—	—	—	**	*	—	*	2
			*	—	—	*	—	—	*	**	—	—	—	3
				—	—	—	**	**	**	*	**	—	**	4
					—	—	*	*	**	*	**	—	**	5
						—	*	*	**	*	**	—	**	6
							**	*	**	*	**	—	**	7
								—	*	**	—	—	—	8
									*	**	—	—	—	9
										**	—	**	—	10
											**	**	**	11
												**	—	12
													**	13
														14

* $P<0.05$.
** $P<0.01$.
— Difference not significant.

TABLE 4. Statistical correlation ('t' test) of karyotypes of *T. aurantii* collected from 7 species of hostplants.

1	2	3	4	5	6	7	
	—	—	*	—	—	*	1
		—	—	—	—	—	2
		—	—	—	—	*	3
				—	*	—	4
					—	—	5
						**	6
							7

* $P<0.05$.
** $P<0.01$.
— Difference not significant.

factors other than the microenvironmental difference (host plant difference) could not be properly assessed in the present study. Therefore, no definite generalization could be made as to whether these differences were strictly due to difference in host plants because in some cases difference in locality of collection with a different ecological condition might also play some role in the karyotypic variation.

The chromosomes of aphids are believed to be holokinetic in nature (WHITE, 1973; KUZNETSOVA, 1980; KHUDA-BUKHSH & DUTTA, 1981). Instances of randomly occurring fragmentations and fusions altering the karyotypes of some parthenogenetically reproducing aphids, sometimes producing structural heterozygotes (BLACKMAN, 1971, 1980a, b, KHUDA - BUKHSH & KAR 1989, are many. However, it has not been precisely known if a particular karyotype is better suited to a particular host plant. Therefore, a more careful study in this direction would be rewarding.

In view of the random chromosomal reorientation after fragmentation, which may be attributed to the discrepencies in karyotypes prepared from various host plant samples, the preparation of the 'standard' karyotype of a given polyphagous species suffers from inherent difficulty. It is therefore suggested that the 'standard' karyotype should have certain allowances for the naturally occurring variations within species and that a range of host-plant samples should be carefully compared for arriving at a reasonably accurate karyotype. Further, the host plant sample and the place of collection should always be mentioned along with the described karyotype. Banding patterns, though difficult to inflict, should be of enormous value in both

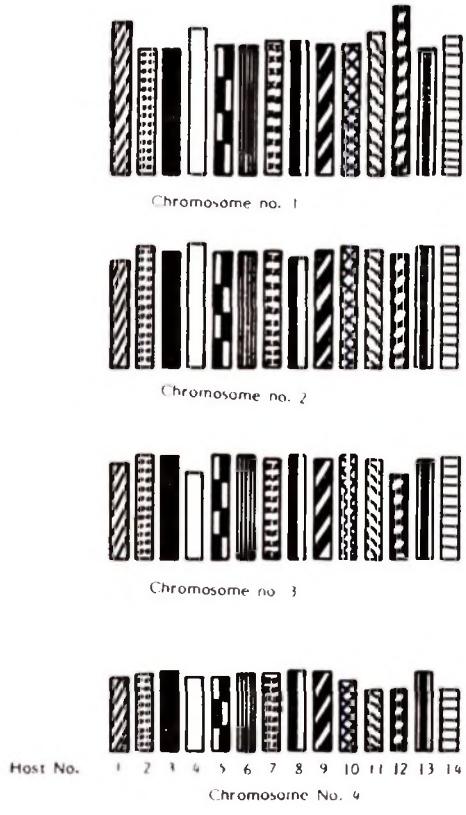


Fig. 22. Comparative idiogram of *A. gossypii* collected from 14 host plant samples; the number corresponds with the serial number of host plant species enlisted in Table 1.

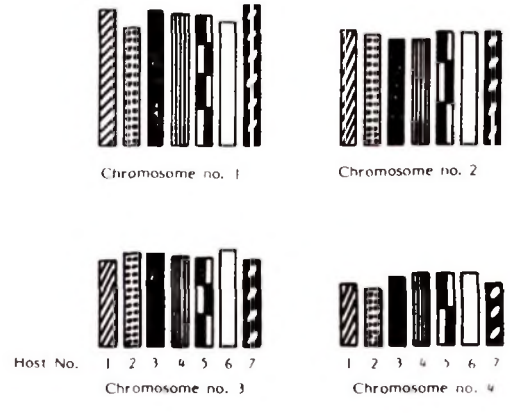


Fig. 23. Comparative idiogram of *T. aurantii* collected from 7 host plant samples; the number corresponds with the serial number of host plant species enlisted in Table 1.

karyotyping and understanding karyo-evolutionary mechanisms within and between species of aphids.

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STUDIES ON THE EVALUATION OF CALCIUM HYDROXIDE AGAINST CYTOPLASMIC POLYHEDROSIS VIRUS OF SILKWORM, *BOMBYX MORI* L.

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Experiments were conducted to study the efficacy of calcium hydroxide against Cytoplasmic Polyhedrosis Virus of silkworm, *Bombyx mori* L. The concentrations tested are non-toxic to silkworms. The chemical concentration, 0.5% is significantly ($P>0.05$) effective against cytoplasmic polyhedrosis virus. The effectiveness of the chemical is dependent on the concentration and the duration of treatments.

(*Key words:* silkworm *Bombyx mori* L, cytoplasmic polyhedrosis virus, calcium hydroxide, efficacy)

INTRODUCTION

Silkworm *Bombyx mori* L., an economically important insect is affected by various diseases caused by several microorganisms (BUCHER, 1963). Among them, viral diseases in India are responsible for the loss of silkworm cocoon crop to the extent of 30–40% (SIDHU & SINGH, 1968). Cuytoplasmic Polyhedrosis Virus (CPV) causes viral *Flacherie* in silkworms. It is popularly known as "Bile Sappe" in India and the studies on this disease are limited. Recently, KAWAKITA (1985) during the studies on the incidence of silkworm diseases in Karnataka (India) reported the CPV in more than 60% of the samples collected. The present method in practice for reducing the incidence of disease is the eradication of disease causing pathogens from the rearing chamber through disinfection. For his purpose, 2–4% formalin solution is sprayed in the rearing chamber (NANGO, 1972). Though formalin has strong killing effect on various silkworm pathogens it has been found to be less effective against CPV (IYENGAR *et al.*, 1988). Therefore, studies on the selective chemicals for using in the control of CPV without adversely affecting the silkworms is necessary. The present paper reports the laboratory investigations on the efficacy of calcium hydroxide against the CPV of silkworms.

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MATERIAL AND METHODS

The pathogens were obtained from its host insect, *B. mori* L. Silkworm midguts infected with CPV were ground with pestle and morter in sterilised water. The tissue debris was removed by filtering through the nylon bolting cloth. The semipurified CPV suspension was obtained by repeated washing of the filtrate through centrifugations at 3500 rpm for 10 minutes. Thus purified, the suspension was stored at 5°C until further use. Two chemical concentrations: 0.1% and 0.5% of calcium hydroxide (Sarabhai chemichals Ltd., Baroda) were prepared in distilled water. The pH of the chemical concentrations were recorded using pH paper (BDH). Cytoplasmic polyhedrosis virus suspension of 0.5 ml contain-

ing 10^7 polyhedra/ml was treated with 1.0 ml of each chemical concentrations for different timings: 5, 15, 30, 45, and 60 minutes.

Toxicity tests:

The toxicity of calcium hydroxide was determined by feeding the silkworms of first day III instar with mulberry leaves dipped in chemical solutions for 60 seconds and air dried. The fresh leaves were provided to the larvae after 24 h of feeding.

Effect of chemical concentrations on CPV:

The bioassay experiments were conducted following the method (DAVID *et al.*, 1971a,b). Mulberry leaves were sterilised by dipping in 70% alcohol for 5 seconds. After the evaporation of alcohol, one ml of treated CPV suspension was smeared over the leaves, air dried and provided to first day III instar silkworm larvae for feeding. Fresh mulberry leaves were provided to the larvae after 24 h of feeding. Cytoplasmic polyhedrosis virus suspension treated with distilled water and infected to the larvae served as control. Three replications each containing 20 silkworms were maintained.

Silkworms in treated and control batches were reared under similar conditions as per the specifications of ANOYMOUS (1975). The average body weights of 10 silkworms were recorded on first day in IV, V instars and on the 4th day in V instar. Observations were made on the development of disease symptoms and larval mortality. Dead larvae during rearing were subjected to microscopic examination for CPV infection. All silkworms were sacrificed on the 6th day in V instar for testing of CPV infection. Data was statistically analysed. The effect of treatment of different chemical concentrations for different timings on CPV was determined analysing the data using F test.

RESULTS AND DISCUSSIONS

Table 1 summarizes the results with treatment of calcium hydroxide on silkworms. The results of larval weights of silkworms fed with leaves dipped in 0.1% and 0.5% calcium hydroxide solutions showed no significant differences compared to larval weights of batches reared normally. This suggests that the chemical does not have an adverse effect on the development of silkworms. But, there is a significant difference (at 5% level) in the larval weights of silkworms infected with CPV (control) compared to those infected with chemically treated CPV (Table 1). In the control batches, after 5–6 days of infection, the larvae became sluggish, the body weight fell and the larval mortality was noticed within 8–10 days. Similar observations were made by HUKUHARA & MIDORIKAWA (1983). On the other hand, such symptoms were not noticed in the larvae infected with chemically treated CPV. Further, the statistical analysis of the data revealed a significant difference ($P > 0.05$) among the larval weights of CPV infected batches and that of chemically treated CPV infected batches.

The pH of the calcium hydroxide solution was 11.0. HUKUHARA & HASHIMOTO (1966) used high alkaline solutions (0.2M Na_2CO_3 and 0.2M $NaHCO_3$) to liberate the virions from the polyhedral bodies of silkworms. The dissolution of nuclear polyhedra under the alkaline conditions were observed (SITTINSONGKRAM & RAKSANG, 1987). In the present study, it was noticed that exposing of CPV to high alkaline conditions of calcium hydroxide inactivated the virus. The results of bioassay experiments confirmed the loss of pathogenicity of viruses released from polyhedral bodies. Hence, a considerable increase in the mean numbers of healthy larvae were observed in the batches infected with chemically treated CPV compared to control. The mean

TABLE 1. Effect of calcium hydroxide on larval weights.

Treatments	Chemical concern-treation (%)	Mean larval weights (g) IV instar I day	V instar I day	V instar 4th day
Mulberry leaves dipped in chemical and fed to larvae	0.1	2.26 ± 0.01	10.53 ± 0.14	25.26 ± 0.42
	0.5	2.35 ± 0.07	10.35 ± 0.11	26.06 ± 0.35
Normal rearings	—	2.32 ± 0.11	10.14 ± 1.11	26.37 ± 0.48
CPV treated with chemical for different durations(Minutes)				
5	0.1	2.09 ± 0.05	9.96 ± 0.70	24.13 ± 0.29*
	0.5	2.16 ± 0.01	9.70 ± 0.14	22.16 ± 1.91*
15	0.1	2.04 ± 0.02	10.43 ± 0.00	24.88 ± 0.00
	0.5	2.14 ± 0.03	9.35 ± 0.48	24.67 ± 0.52*
30	0.1	2.23 ± 0.10	8.85 ± 0.00	25.01 ± 0.00
	0.5	2.21 ± 0.07	9.96 ± 0.34	25.05 ± 0.88*
45	0.1	2.13 ± 0.08	10.00 ± 0.35	24.06 ± 0.24*
	0.5	2.12 ± 0.11	9.83 ± 0.63	24.42 ± 0.57
60	0.1	1.73 ± 0.04	8.90 ± 0.28	24.66 ± 2.32*
	0.5	2.14 ± 0.09	9.71 ± 0.56	25.21 ± 0.57*
Control	—	1.87 ± 0.14	6.93 ± 2.44	9.50 ± 2.77

*Significant at 5% level. Figures indicate averages of 3 replicates.

TABLE 2. Effect of calcium hydroxide on cytoplasmic polyhedrosis virus.

Treatments Duration (minutes)	Chemical concentrations (%)	Mean number of healthy larvae
5	0.1	9.5 ± 0.71
	0.5	10.0 ± 0.41
15	0.1	11.5 ± 2.12
	0.5	14.5 ± 0.71*
30	0.1	14.5 ± 0.71*
	0.5	14.5 ± 0.71*
45	0.1	15.5 ± 0.71*
	0.5	15.5 ± 0.71*
60	0.1	16.0 ± 1.41*
	0.5	16.0 ± 1.41*
Control		6.6 ± 2.12

*Significant at 5% level.
Figures indicate average of 3 replicates.

numbers of healthy larvae in the 5 minutes treated batch was 9.5 ± 0.77 while it increased to 16.0 ± 1.44 in the 60 minutes treated batches. On the other hand, the mean numbers of healthy larvae in control batch was 6.5 ± 2.12 only (Table 2).

The results of 'F' test showed that the treatments given for 15 minutes and above durations have significant effect ($P>0.01$) over other treatments. Also, 0.5% of chemical concentrations is more effective ($P>0.05$) compared to 0.1% concentration.

The present findings showed that the calcium hydroxide is non-toxic to silkworms and it is effective against CPV. The extent of inactivation of virus and the concurrent increase in the mean numbers of healthy larvae are dependent on chemical concentrations and the duration of treatments.

Therefore, calcium hydroxide could be used during disinfection of silkworm rearing chambers for the control of cytoplasmic polyhedrosis virus.

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EFFECT OF NITROGENOUS FERTILIZATON OF HOST PLANTS ON SOME GROWTH PARAMETERS OF *HELIOTHIS ARMIGERA* HUBNER

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The effect of varying levels of nitrogenous fertilization of sunflower plants on some growth parameters of *Heliothis armigera* larvae were studied in the laboratory. The larval period was significantly reduced when larvae fed with the leaves from plants fertilized with higher N level (120 kg/ha). The weight gained by both the immature stages *i. e.*, larva and pupa, approximate digestibility, efficiency of conversion of ingested food and efficiency of conversion of digested food were higher when larvae fed with food treated with 120 kg N/ha. The overall superiority of larval development in higher N treatment was due to higher efficiency of conversion of ingested and digested food into biomass.

(*Key words:* N nutrition, growth parameters, *Heliothis armigera*)

INTRODUCTION

The increased use of nitrogenous fertilizers in agriculture modifies the chemical composition of the crop plants and thus the development or arthropods feeding on them. Reliable information on the effect of nitrogenous fertilization to food plant on insect growth and development is essential to understand the nutritional behaviour of insects and host plant relationship in order to optimise the use of resources to avoid loss.

A few workers have studied the effect of nitrogenous fertilization of host plants on growth and development of insects (MYRS, 1985; KANDA, 1987). Susceptibility of cotton plants to *Heliothis* spp. was reported to be increasing with an increasing rate of nitrogen (ADKISSON, 1958; VILLAMAYOR, 1976). However, information on the effect of N nutrition of host plants on growth and development of *Heliothis* larvae is lacking. Hence, the present investigation was undertaken to determine the effect of N nutrition on development period, weight gain, approximate digestibility, efficiency of conversion of ingested food and efficiency of conversion of digested food of *H. armigera* larvae.

MATERIALS AND METHODS

The effect of varying concentrations of N applied to sunflower plants on the development, body weight, food consumption and food utilization of *Heliothis* larvae were studied under laboratory condition. The experiment was laid out in completely randomized design with four treatments including control (no fertilizer). The neonate larvae, obtained from the laboratory stock were reared on leaves of sunflower, taken from plants in field plots that had received 4 levels of nitrogenous fertilizer application, viz., 0. 40, 80, 120 kg/ha. Two square pieces (6 × 6 cm approximately) of sunflower leaves of each treatment were placed in the plastic box (7.5 × 3.5 cm). A single larva was released in each plastic box and overall 10 larvae were

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allotted to each treatment. The larvae were allowed to feed on food material and supplied with respective fresh food every day, until pupation.

The development period of larvae and pupae as well as body weight of full grown larvae and pupae were obtained treatment-wise. The various growth indices like consumption index (CI), approximate digestibility (A D), efficiency of conversion of ingested food to tissue (ECI) and efficiency of conversion of digested food to tissue (ECD) were worked out as per the formulae suggested by WALDBAUER (1968). These growth parameters were only worked out for the late instar larvae.

RESULTS AND DISCUSSION

Effect of various levels of nitrogenous fertilization on development period and body weight of larvae and pupae are presented in Tables 1 and 2, respectively. The data revealed that the average number of days required to complete entire larval stage was significantly less (13.25 days) in N_3 treatment as compared to N_0 (15.50 days), N_1 (15.50 days) and N_2 (14.50 days) treatments. Pupal period was not significantly affected by the various N level treatments. However, under higher level of N fertilization (120 kg/ha) time required to complete pupal stage was slightly less (9.75 days) than rest of the treatments. The weight of larvae and pupae was significantly affected by the various N treatments (Table 2). Significantly higher weight gained by larvae in N_3 (0.280 g) and N_2 (0.270 g) over N_0 (0.240 g) treatment. The pupal weight was also significantly higher in N_3 (0.279 g) followed by N_2 (0.260 g) and N_1 (0.230 g) treatments. From the results, it is evident that the larvae grew

TABLE 1. Effect of N on larval and pupal period of *H. armigera*.

Treatment	Duration (days)		't' value in comparson to N_0	
	Larval	Pupal	Larval	Pupal
N_0	15.50 ± 0.57	10.50 ± 0.57	—	—
N_1	15.50 ± 0.50	10.0 ± 0.81	1.23	1.75
N_2	14.50 ± 0.57	10.0 ± 0.00	2.20	1.76
N_3	13.25 ± 0.95	9.75 ± 0.95	3.20*	1.80

* Significant at 5 % level.

TABLE 2. Effect of N on weight of full grown larvae and pupae of *H. armigera*.

Treatment	Mean wt. in g		(t) value in comparison to N_0	
	Larvae	Pupae	Larvae	pupae
N_0	0.240 ± 0.03	0.240 ± 0.04	—	—
N_1	0.240 ± 0.04	0.230 ± 0.04	0.10	0.33
N_2	0.270 ± 0.02	0.260 ± 0.03	2.70*	3.10*
N_3	0.280 ± 0.03	0.270 ± 0.04	3.10*	3.20*

* Significant at 5% level.

TABLE 3. Effect of N on the consumption and utilization of food by the last instar *H. armigera* larva (on fresh weight basis).

Treatment	Weight of food ingested (g) days after hatching			Weight of faeces (g) days after hatching			Consumption index	Approximate digestibility (%) days after hatching			Efficiency of conversion of ingested food (%)	Efficiency of conversion of digested food (%)
	9th	10th	11th	9th	10th	11th		9th	10th	11th		
N_0	0.430	0.480	1.140	0.210	0.220	0.690	1.80	51.20	54.16	39.47	26.10	48.00
N_1	0.420	0.500	1.180	0.170	0.230	0.720	1.91	52.30	54.00	38.98	26.00	48.87
N_2	0.470	0.530	1.450	0.280	0.240	0.930	1.94	53.20	54.72	37.86	27.50	51.60
N_3	0.500	0.640	1.110	0.230	0.300	0.720	2.00	55.30	53.12	35.23	28.50	54.90
SEm	0.013	0.017	0.04	0.028	0.024	0.039	0.04	0.73	0.83	0.412	0.41	00.90
CD	0.040	0.056	0.13	N.S.	N.S.	N.S.	0.13	2.16	N.S.	N.S.	1.34	2.70

faster and attained heavier weight, when grown on leaves from plants fertilized with higher N treatments. These results clearly indicated that N fertilizer had considerable effect on food quality. Such food were more preferred by larvae which in turn supported the development in shorter period and also helped in gaining heavier weight. The present results are supported by the findings of ZING *et al.* (1982) who observed that the N fertilizer application to the cotton plants had increased the weight of the late instar *H. armigera* larvae and pupae. Such effect of N fertilization of host plants when used as food was found to have enhanced the larval development and their body weight in cabbage butterfly, *Pieris rapae* on cabbage (MYRES, 1985) and spruce budworm, *Choristoneura occidentalis* on Douglas Fir (BREWER *et al.*, 1987; CATES *et al.*, 1987).

The data in respect of various growth indices are presented in Table 3. From the data it could be seen that the ingestion of food was significantly higher (0.500 g) in N_3 over all other treatments in 9 and 10 days old larvae. The trend was changed in 11 days old larvae, wherein significantly lower food ingestion was noticed in N_3 than rest of the treatments. This might be due to early advancement of larval stage. The weight of faeces did not differ significantly among the various N levels. These results indicated that the amount of food ingested and amount of faeces excreted did not show significant relationship. This could be due to the difference in digestibility of the food nutrition as influenced by N treatments. The higher consumption index (2.0) in N_3 treatment showed the suitability of food. The AD was significantly higher in N_3 treatment in 9 days old larvae. ZING *et al.* (1982) reported that the N treatments to cotton plants increased the food assimilation efficiency of 6th instar *H. armigera* larvae. Further dcrease in AD value was noted in 10 and 11 days old larvae in all the treatments. Although, AD was non-significant among N treatments in 10 and 11 days old larvae, the N_3 level had recorded slightly lower AD value than all other treatments. This might be due to early advancement of age of larvae. Such phenomenon was reported by KHALSA (1973) who stated that the digestion of food decreased with the advanced larval instars.

The data on indices of utilization of food (Table 3) *i. e.* E C I and E C D showed that the food treated with N_3 level was highly digested and was efficiently utilized for larval development. This can be evident from the significantly higher value of E C I (28.50%) and E C D (54.90%) in N_3 treatment. The food intake in N_0, N_1 and N_2 treatments though digestible, but the digested food was not efficiently utilized for growth as it was the case with N_3 treatment. Thus the overall superiority of larval development in N_3 treatment was due to high E C I and E C D. SHAARAWY *et al.* (1975) obtained higher percentage of conversion of ingested or digested food in all instars of eri silkworm larvae when reared on caster leaves from plots received N at 30 kg/Feddan (0.42 ha) as compared to plots receiving no N. In the absence of any evidence of effects of N fertilization of host plants on the utilization of food by *H. armigera* larvae, it may be accepted that the treatment of higher N (120 kg/ha) have increased the nutritional value of sunflower plants and also considerably effected the biochemistry of the host plant. This increased nutritional status in turn enhanced the food utilization capacity of *H. armigera* larvae.

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BRIEF COMMUNICATION

OBSERVATIONS ON *ANERISTUS CEROPLASTAE* HOWARD (HYMENOPTERA : APHELINIDAE) A PARASITOID OF MANGO SCALE, *CHLOROPULVINARIA POLYGONATA* (HOMOPTERA : COCCIDAE)

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The behaviour of *Aneristus ceroplastae* Howard the parasitoid of mango scale *Chloropulvinaria polygonata*, and the percentage of parasitization instar-wise and sex-wise of the scale have been reported.

(*Key words: Aneristus ceroplastae*, *Chloropulvinarea polygonata*, oviposition, parasitization)

Aneristus ceroplastae Howard was found parasitizing the mango scale *Chloropulvinaria polygonata* at Bhagalpur. The adult parasitoids are free-living and they were often observed rubbing the surface of the leaves and soft twigs of mango by their mouthparts. The significance of this behaviour is not fully understood, but perhaps it indicates a sort of external feeding on the surface tissue and / or fluid. However, it needs further investigation and confirmation. The adult parasitoid prefers to oviposit in the first, second and third instar female scales. The average time taken for oviposition is 3-5 sec/scale. One parasitoid was observed making attempts to oviposit into 20 scales successively within a period of 30 min. The young parasitoid larva, lying inside the scale's body, is somewhat milky in colour but the late larva turns brownish and vermiform, with broad end straight and the narrow end curved. The head of the larva lies at the posterior end of the scale's body and the tail towards the anterior end. The pupa is jet-black in colour, and so is the adult parasitoid. Hence the straw-coloured immature scales look in late stage of parasitization jet black and can be easily spotted out, but the adult female scale whose own colour is blackish or dark slaty cannot be recognised for parasitization on the basis of colour, until the emergence hole has been formed by the adult parasitoid for its escape.

To study the percentage of parasitization in various instars, the number of parasitized scales was counted instar-wise on ten infested leaves at seven day intervals, for a period of one year (Table 1). The table shows the following percentages of parasitization-first instar 1.57%, second instar 3.44%, third instar female 54.7%, fourth instar female (adult) 22.54%, prepupa 0.0%, pupa 0.0%, and adult male 0.0%. But, it is possible that in the first and second instars, the percentage of parasitization could be more than what it apparently appears on the basis of body colour, because many first and second instar scales were still in early stage of parasitization, when distinct external symptom of parasitization (blackening of body) had not appeared. It was surprising that not a single case of parasitization was found in male scales

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TABLE 1. Number of nonparasitized and parasitized scale of *C. polygonata* (collected during the period of one year).

Months	I Instar		II Instar		III Instar Female		IV Instar Female		Prepupa		Pupa		Adult	
	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
September	1470	27	82	14	A	A	A	A	A	A	A	A	A	A
October	A	A	139	20	165	500	218	21	446	A	508	A	60	A
November	A	A	A	A	A	A	1230	101	A	A	A	A	40	A
December	3820	57	A	A	A	A	120	10	A	A	A	A	A	A
January	870	10	1925	30	455	30	99	5	739	A	514	A	13	A
February	A	A	A	A	A	A	838	60	A	A	206	A	16	A
March	1694	22	A	A	A	A	390	26	A	A	A	A	A	A
April	1608	18	1255	45	545	817	A	A	495	A	285	A	10	A
May	A	A	A	A	350	250	2055	289	A	A	315	A	30	A
June	5900	117	510	40	A	A	320	34	A	A	A	A	A	A
July	762	11	936	24	563	919	166	340	419	A	339	A	48	A
August	570	5	A	A	A	A	1457	1120	A	A	A	A	16	A
Total	16694	267	4847	173	2078	2516	6893	2006	2099	A	2167	A	233	A
Grand total	16961		5020		4594		8899		2099		2167		233	
Instarwise %	98.43	1.57	96.55	3.44	45.33	54.76	77.45	22.54	100%	00	100	00	100	00

Nonparasitized = NP; Parasitized = P; Absent = A.

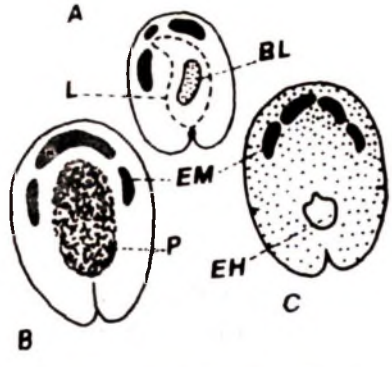

Fig. 1. *Aneristus ceroplastae* Howard: A. Larva (inside the body of second instar scale); B. Pupa (inside the body of third instar scale); C. Empty third instar scale's body with emergence hole. BL—Brownish lump; L—Larva of parasitoid; EH—Emergence hole; P—Pupa of parasitoid EM—Excretory matter;

(prepupa, pupa and adult) though there were hundreds of such scales on the infested leaves alongwith the parasitized female scales. The reason for this selective oviposition by the adult parasitoid is not known.

Not much is known about the behaviour of the adult parasitoid *A. ceroplastae* specially those parasitizing *C. polygonata*. AHMAD & MUZAFFAR (1974) from Pakistan reported that *A. ceroplastae* attacked 0.6%—12.0 % of *C. polygonata* scale (on host plant *Thevetia neriifolia*) and that the former was itself parasitized by *Marietta* sp. (up to 3.5%), which the present authors did not observe. HUANG (1981) also reported about *A. ceroplastae* parasitizing *C. polygonata*

in two provinces of China, the rate of parasitism ranging between 47.5%—73.6%; but he has not mentioned about instar-wise and sex-wise parasitization.

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BRIEF COMMUNICATION

COMPARATIVE STUDY OF HAEMOCYTE POPULATIONS IN SCORPIONS

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Haemocyte studies showed that highest THC was in *Mesobuthus tamulus* with embryos; lowest in non-embryo bearing *Heterometrus xanthopus*.

(*Key words:* haemocytes, scorpions, embryo bearing and non embryo-bearing, females, males)

Information on the haemocytes of Indian scorpions is inadequate. An account of the morphology of haemocytes of *Palumnaeus swammerdami* (RAVINDRANATH, 1974) represents the only work on the haemocytes of an Indian scorpion. Knowledge of the haemocyte morphology in general and their population in particular is essential for biological and physiological studies. The haemocyte population in different arthropods varies during development, physiological states, starvation, dessication, wounding and infection etc. (JONES, 1962; MORE & SONAWANE, 1987; DADAS, 1989). The following report presents some interesting findings and basic data on the haemocyte populations in different species of scorpions.

Five species : (1) *Mesobuthus tamulus* (Fabr.), (2) *Mesobuthus tamulus concanensis* (Pocock) and (3) *Orthochirus bicolor* (Pocock) belonging to Buthidae and (4) *Heterometrus xanthopus* (Pocock) and (5) *Heterometrus phipsoni* (Pocock) belonging to Scorpionidae were used in the present study. The specimens were collected from different localities in Sangli and Ratnagiri districts. All collections were made in the morning between 7.00 AM to 10.00 AM during the period from September, 1987 to May, 1988. Males and females of each species were kept separately in perforated plastic jars. The animals were maintained on a diet of small roaches with a provision of drinking water in each jar.

Haemolymph required for the determination of the total haemocyte count (THC) was obtained by amputating a pedipalp. After diluting the haemolymph drop with saline-versene (2%) mixture in Thoma-Zeiss haemocytometer the haemocytes were counted in the Neubaur's chamber (SONAWANE, 1985; WITTIG, 1966). The following formula of JONES (1965) was adopted for calculations:

THC = Haemocytes in 1 mm square × dilution × depth of the chamber / number of 1 mm square counted.

Simultaneously, air-dried monolayers of the haemolymph from each species were prepared and stained with Pappenheim's panchrome. The haemocyte types were identified according to the identification key of GUPTA (1985).

Seven types of haemocytes: prohaemocytes, plasmatocytes, granulocytes, spherulocytes, adipohaemocytes, oenocytoids and coagulocytes were identified in the stained preparations in all the species.

The figures for THC in the species of scorpions are given in the following table:

TABLE 1. Total haemocyte count (THC) in scorpions.

S. no.	Species	THC		
		Male	Female Non-embryo bearing	Female Embryo bearing
1.	*Mesobuthus tamulus tamulus*	10,906 ±330	10,056 ±010	11,235 ±080
2.	*Mesobuthus tamulus concanensis*	46,836 ±074	45,431 ±118	47,397 ±180
3.	*Orthochirus bicolar*	11,679 ±098	110,93 ±011	11,990 ±003
4.	*Heterometrus xanthopus*	9,809 ±049	9,161 ±099	10,947 ±084
5.	*Heterometrus phipsoni*	10,509 ±019	9,608 ±010	11,149 ±102

The THC figures indicated the following features: Highest THC (47, 397/mm^3) was recorded in the embryo-bearing females of *M. tamulus concanensis* and the lowest (9,161/mm^3) in the non-embryo-bearing females of *H. xanthopus*. The THC of the embryo-bearing females in all the species was always higher than THC of the non-embryo-bearing females and the males of the same species. These results indicated an increasing trend in the THC in the females during pregnancy. The haemocytes of arthropods are known to respond to various factors, which might be instrinsic or extrinsic. This was particularly evident during growth and development (SHAPIRO, 1979). This suggested that the haemoplymph picture was a mirror of developmental changes. The increase in THC during pregnancy seemed to be ralated to the viviparous nature of scorpions where-in females have an additional load of sustenance and nourishment of the developing embryos.

Another interesting observation made in the present study was the finding of a very high THC in the males and females of *M. tamulus concanensis* (above 45,000/mm)^3. In other species the counts mostly ranged between 9,000 to 12,000/mm^3. *M tamulus concanensis* is the most venomous species of scorpions found in India (TIKADER & BASTAWADE, 1983). Whether there is any relation between the high THC and the strongly venomous nature of this species is a subject for future research.

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BRIEF COMMUNICATION

NEW RECORDS OF COLEOPTERA FROM SOUTH ANDAMAN

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While surveying the insect pests of agri- horti-silvicultural plants during 1988-1989, it was recorded for the first time that *Hoplasoma unicolar* **(Illiger) defoliated** *Clerodendrum viscosum; Spondotriplax andamana* **Arrow destroyed** *Pleurotus sajor caju; Gonophora masoni* **Baly scraped epidermis of** *Curcuma* **sp. leaves;** *Diocalandra taitense* **(Gue'rin-Mene'ville) bored the nuts of** *Cocos nucifera.*

(*Key words: Hoplasoma unicolor, Spondotriplax andamana, Gonophora masoni, Diocalandra taitense*)

Extensive survey for insect pests of agri-horti-silvicultural plants is undertaken since 1988 in Andaman and Nicobar Group of islands. The following few coleopterous insect pests were recorded for the first time in India from South Andaman.

1. *Hoplasoma unicolor* (Illiger) (Chrysomelidae)

During March-April, 1988 the leaves of *Clerodendrum viscosum* Vent., a waste land weed were damaged by adult beetles of *H. unicolor*. The adult beetle looks like red pumpkin beetle, but is a little bigger and brighter. Adult beetle measured 9 × 2.5 mm is size, and can be easily confused for red pumpkin beetle. The adult beetles feed on *Clerodendrum* leaves irregularly from leaf margin. Adult beetles could sense slight disturbance and took to flight.

H. sexmaculata Hope was earlier recorded defoliating peach leaves (NAIR, 1975).

2. *Spondotriplax andamana* Arrow (Erotylidae)

This beetle has been reared on and recorded as a pest of *Pleurotus sajor caju* a cultivated tropical mushroom. During August, 1988 most of the mushrooms were found infested by the grubs of *S. andamana*. The infestation was noticed on first and subsequent crop of mushroom. The level of infestation was very high and cent percent mushrooms were found attacked by this insect. Very small, white coloured grubs were found in between septa and made their way across and fed on the contents. On an average 14.5 grubs were recorded per single mushroom with a range from 7 to 23. The infested mushrooms were not acceptable for cooking by the consumer. The grubs pupated in drying mushrooms. Pupal period lasted for 5–7 days.

Adult beetle is oval shaped, 3.5 × 2 mm in size. It is light brown coloured and had characteristic black spots (Fig. 1). The eyes are very small and black in colour. Antenna is three segmented.

Most of the species of *Erotylidae* are known to infest the fruiting bodies of fungi (IMMS, 1973).

3. *Gonophora masoni* Baly (Chrysomelidae)

Beetles of *G. masoni* were found scraping the leaf surface of *Curcuma* sp., an uncultivated species. The infestation was noticed during November. Yellowish beetles measured 6 × 2.5 mm in size. The elytra

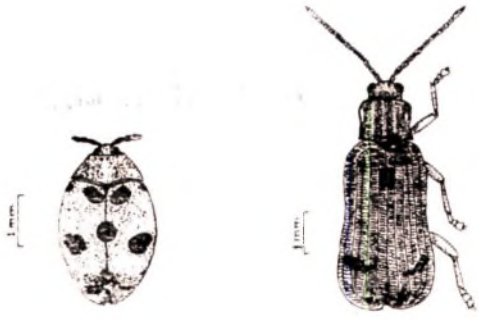

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Fig. 1. *Spondotriplax andamana* Arrow

Fig. 2. *Gonophora masoni* Baly

were matty with raised thin lines and with characteristic black spots (Fig. 2). The beetles scraped the green matter longitudinaally in between veins on the dorsal surface of leaves. The number of beetles per leaf ranged from 2 to 19 and the infestation was not noticed during other months.

The cultivated species of *Curcuma* was not infested by this beetle. Rhizomes of uncultivated *Curcuma* sp. were used for pickle making by the local people of South Andaman.

4. *Diocalandra taitense* (Guerin-Meneville) (Curculionidae)

During September-October, 1988 a few malformed green coconuts were noticed on a plant in Sipighat farm. Close examination revealed that the grubs of *D. taitense* bored these nuts. Adult is a very small weevil, dark brown coloured and 6×1 mm in size, with a prominent snout. The grub bored the husk of green coconut and fed on the contents. Infested coconuts did not develop properly and were malformed.

D. stigmaticollis Gyll. was recorded to infest the cuts and wounds on the petiole and trunk of coconut tree, inflorescence of areca palm in Kerala (JOSEPH, 1949). *D. taitensis* was recorded on trunk (CORBETT, 1922) of coconut in Malaysia, on spathe and trunk of coconut in Papua New Guinea (JOHNSTON, 1965) and on coconut inflorescence in Philippines (HERMS, 1926).

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BRIEF COMMUNICATION

HORMONAL INFLUENCE ON THE HAEMOLYMPH TREHALOSE CONCENTRATION IN THE DRAGONFLY *TRAMEA VIRGINIA* (RAMBUR) LARVA

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(*Received* 30 *June* 1990)

In the last instar nymph of the dragonfly *Tramea virginia*, the haemolymph trehalose concentration besides attaining a peak level on the 24th day, depleted rapidly with the onset of final metamorphosis. Experimental studies revealed the hypertrehalosemic nature of the intrisic hormones of the corpora cardiaca.

(*Key words:* *Tramea virginia*, haemolymph trehalose, corpora cardiaca)

Although trehalose has been determined as major haemolymph sugar in some dragonflies (THAKARE *et al.*, 1980), no substantial information is however, available in Odonata on various aspects of carbohydrate metabolism and its hormonal regulation (STEELE, 1985). The present work was therefore undertaken in the last instar larva of *Tramea virginia*.

The haemolymph was collected from the larvae at a regular interval of 4 days since emergence till their transformation into adults. The haemolymph trehalose concentration (HTC) was determined by the method of DAHLMAN (1973). All experiments were designed as described earlier (TEMBHARE & THAKARE, 1976. In accordance with the dose dependent curve (ANDREW, 1989), the quantity of the corpus cardiacum (CC) extract equivalent to a single corpus cardiacum and 1 μg farnesyl methyl ether (FME) were injected per larva and equal quantity of saline and olive oil was injected in their respective controls. The HTC in the experimental and control larvae was determined at the intervals of 1, 2, 4 and 6 hours. 6–10 replicates were used for each experiment.

The HTC (Fig. 1) varied greatly during the intermoult period. It attained a peak level on the 24th day but thereafter, reduced significantly, thus indicating excessive utilisation of haemolymph trehalose during the final moult. Similar changes in the HTC have also been reported in other insects (CHEN, 1971).

Cauterization of the medial neurosecretory cells of the brain as well as administration of FME did not exert any significant effect on

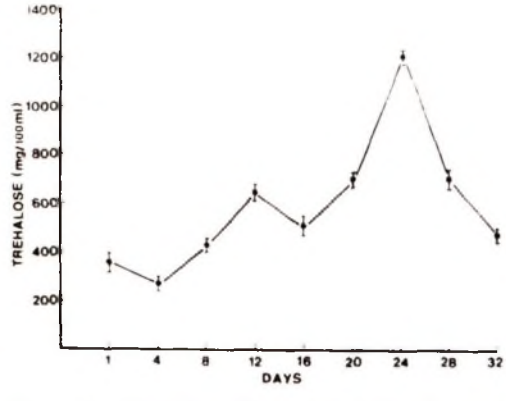

Fig. 1. Concentration of haemolymph trehalose in the last instar larvae from ecdysis until the final moult. Vertical bars represent standard error.

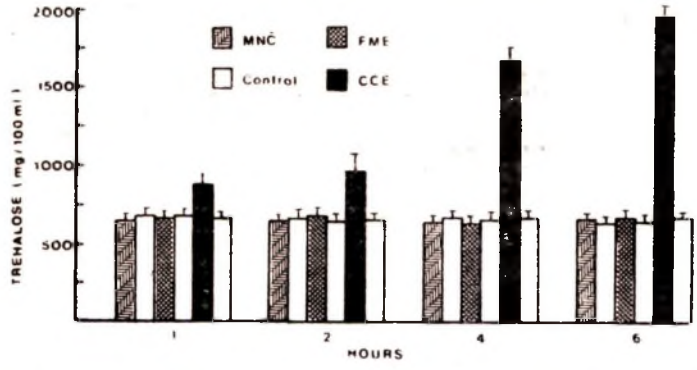

Fig. 2. Effect of cauterization of medial eurosecretory cells (MNC), administration of farnesyl methyl ether (FME) and of corpora cardiaca extract (CCE) on haempolymph trehalose concentration.

the HTC, while administration of CC extract elevated HTC upto two and a half times within a period of six hours (Fig. 2).

The secretion of hypertrehalosemic hormone by the intrinsic neurosecretory cells of the CC has been reported in a large number of insects (STEELE, 1985) and the Odonates do not seem to be an exception.

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